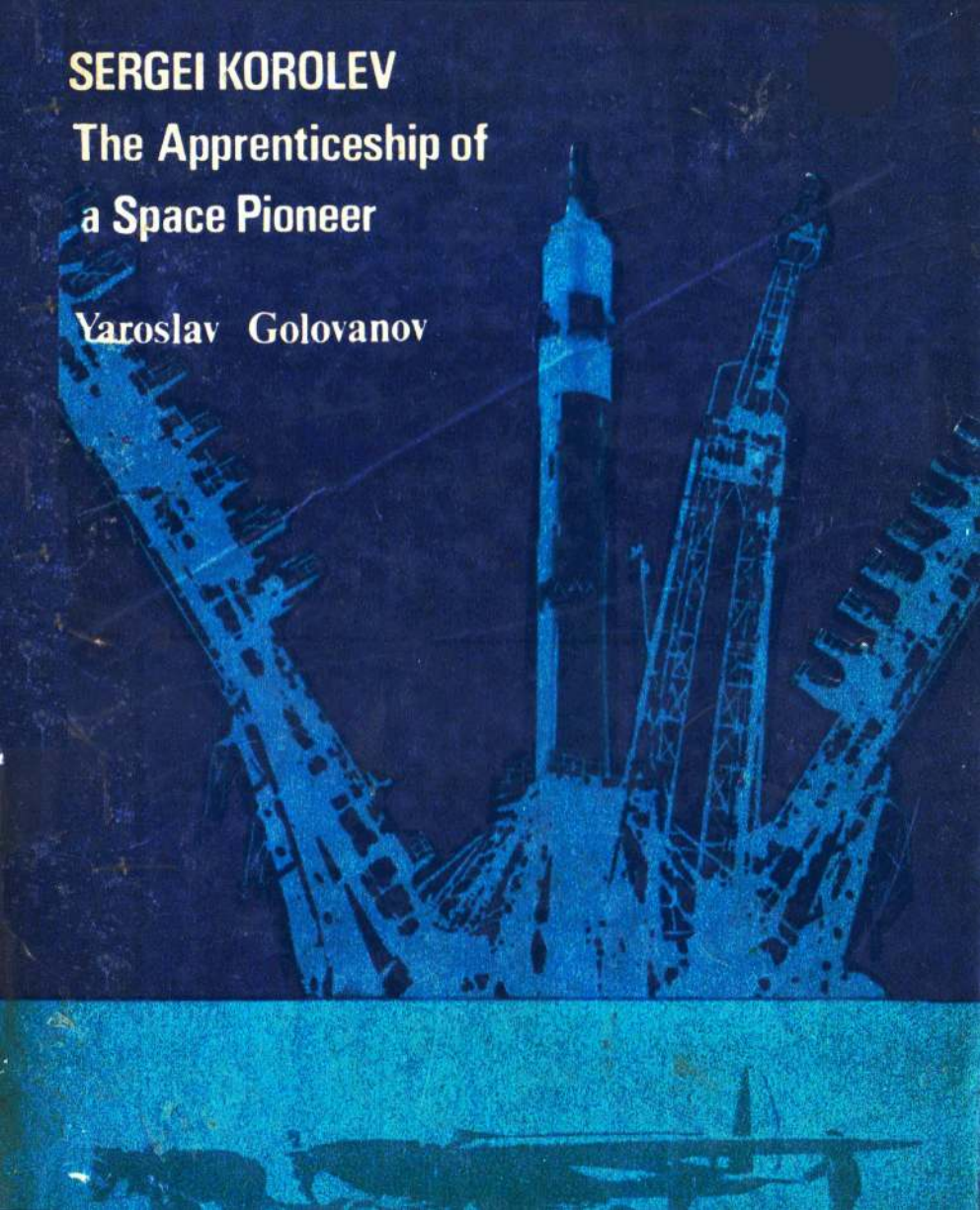
SERGEI KOROLEV
The Apprenticeship of a Space Pioneer

Yaroslav Golovanov



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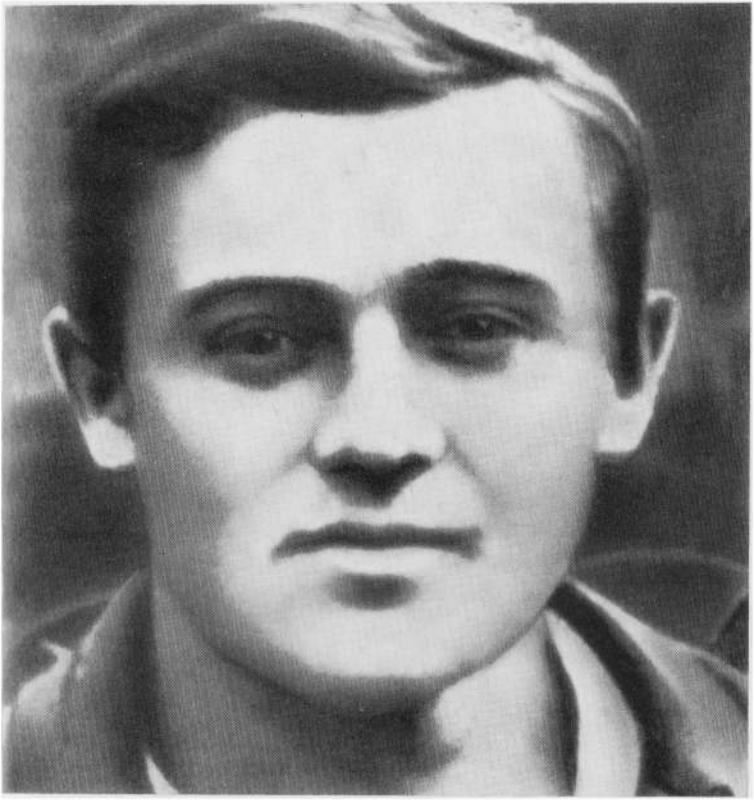

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Translated from the Russian
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Sergei Korolev, the Constructor-in-Chief of the Soviet space programme, had a short powerful neck; when he looked at a rocket he never threw his head back, but seemed to glower at it. People who did not know him well got the impression that he was dissatisfied. But on this day there were no such persons on the launching pad.

Korolev had arrived early, and left his car on the concrete apron. He was now walking slowly up the slight slope to where the rocket was standing. He had 'flu, and probably a fever, but he hadn't taken his temperature or called his doctor. Whatever for? All the same he had no right to fall ill until after the launch. The wind was cold and piercing. Korolev raised the collar of his heavy old overcoat. From the change in the pace of the comings and goings on the launching pad, and the business-like, energetic bearing of those who remained, he knew his arrival had been noted. He nodded to one man, and to another, and crossed the tracks to the bunker. From behind him came the wooden voice of the public address system:

'Attention! Time check in one minute! Prepare to fuel... .'

He knew and sensed that everything was going according to timetable. There was no need to interfere. They knew everything themselves. It would only make people nervous. They were good lads. Now fuelling was beginning. The electric motors of the pumps and fans would start up with a dull rumble, the valves begin to knock like loud, sharp pistol shots, and the air to hiss viciously in the vents. He had heard them all so many times. Every note, every quiet click of the magnetic starter, every rattle of the command-post loudspeaker, for him were part of the melody of a launch, and he would immediately detect any false note in it. He didn't need to look at the instruments.

Everything was all right. The Dewar tanks were closing in slowly. The liquid oxygen was fuming like the white steam of a locomotive. The rocket was becoming shrouded. Rime was creeping up from the bottom of the oxygen tank,

and soon it would be all white. Beautiful. Then a thought came to him: 'What day is it today?' Friday. Russian superstitions consider Mondays and Fridays to be unlucky. Korolev smiled to himself. 'We'll have to break that superstition down... .'

Later, immediately before blast-off, he sat with his shoulders hunched on his usual seat at his 'personal' periscope in the bunker. He was shivering slightly.

'Zero minus one alert, fifteen minutes,' the loudspeaker said in a wooden voice.

'Duty crew leave the pad. Report evacuation of personnel and equipment. Fire-brigades on alert Number One!'

'All this military jargon, all this "personnel" and "Number One alert" causes alarm and produces an impression of danger,' thought Korolev. 'Of course there's danger, anything can happen. No, all this ritual shouldn't be altered. Nor the words. There's not only alarm in the words, but command, precision, order. Try saying "Would you be so kind as to remove the servicing rigs", or "I beg you to leave the launching site". It would be the end, the whole work would go to the devil. The words help to keep a tight grip on everything. A tight grip is needed. A relaxed open hand can do no work. What about a pianist? But no, his hand is not relaxed; he has a firm grip. A fist is, perhaps, the most expressive form the hand can assume.' Korolev looked at his own hand. It was not large, but broad, like his grandfather's. 'What am I thinking about? What nonsense. How these minutes drag! The commands always seem late. But what if some "bug" gets into the works?'

'Zero minus one minute! Repeat: Zero minus one minute!'

'No, everything's O.K. Right on schedule... .'

'Switch to start!'

'Start switched!'

The whole complex of instructions for launching a rocket was going into operation. 'The display is lighting up now,' thought Korolev. He turned round, and immediately, as

if his glance had lit up the dull glass panel, 'Switch to start!' flashed on.

'Vents.'

Korolev brought his face close to the periscope and felt the unpleasant sensation of the cold sweat from his face on the black rubber shield of the eye-pieces. The white oxygen cloud disappeared: the vent valves had been closed. Now boosting of the tanks was beginning.

'First test!' A gale of nitrogen swept through the pipes of the oxidizer and the rocket engine.

'Auxiliary engines pressurized!'

'Main engines pressurized!'

'Engines pressurized!'

'Start!'

'What's that? Did it lurch? Damn, I really am ill. Steady on. Everything's O.K. Only a few seconds to go now, the countdown's starting... .'

'Launch begun!'

'Now the automatic controls are taking over. Of course, it's still possible to hold back the launching. One movement of the hand to the "Reset Circuit" button, and everything... .'

'Ground—disengage!'

Korolev clung to the periscope. The rocket was right before his eyes. He saw how the cable-tower quickly, but smoothly, swung away after the command. Now nothing connected the rocket with the launching part. The electrical circuit had been broken. The fate of this sphere hidden under the cowling depended solely on the rocket, and only on it.

'Ignition!'

'Preliminary boost!'

He saw an instantaneous flash, a short flicker, before the brown cloud of dust and smoke raging in the whirl-wind of the engines rapidly engulfed everything around. It had got as far as the white cowling of the nose cone when a blinding ball of light flared beneath it ahead the thunder that would soon be heard in spite of the concrete shield metres thick.

PART ONE

A Flying Start

'I'm definitely having an unlucky spell. I did not come off well in Ekaterinoslav business, and I only wanted justice. And Maria's behaving quite strangely. In fact, I don't know who has the patience to put up with her indifference. I'm not a boy after all. And she knows my intentions perfectly well. I'll have to propose without delay. It's May already, and in August goodbye! So that's settled. I'll talk to her now, today.' So Pavel Korolev cheered himself up as he walked quickly along Gogolevskaya St., the main street of Nezhin.

People there, by force of habit, called it the Gogolevskaya Boardway, because before it was paved with cobble stones it had been covered along its whole length with wooden planks, as Gogol recalled in *Dead Souls*, describing the street in Plyushkin's village. The street ran right through the town, past Kushakevich's Girls' High School, past the square with the monument, to the cathedral, and the market place. Right here, on the corner of the Boardway and Stephano-Yavorskaya St., stood the Moskalenko's grocery. The owner, Nikolai Moskalenko, was a staid, reticent man, unlike some shop-keepers, sharp, hasty, and quite restless. His passport described him as a 'Cossack of the Nezhin regiment'. He had the appearance of a true Cossack, broad in the shoulders and in the waist, with drooping moustache touched with silver, that would have been the envy of any true Zaporozhye Cossack.

The numerous Moskalenko family—his wife Maria, his sons Yuri and Vasily, and his daughters Maria and Anna, not counting the servants, dwelt in a big house built after the Greek fashion, the roof of which was impossible to see from the shop behind the mighty tree tops of Gogolevsky Square, though the house was nevertheless quite close to it. The owner himself was seldom at home. He spent his days in the shop among sugar loaves, sacks of flour, packets

with tea, cereals and sweets. Because of the proximity of a church Nikolai Moskalenko was not allowed to sell wine, and if a customer asked for a bottle of sherry or of madeira, he sent the shop-boy to the cellar of the house.

The house was the domain of his wife, who was also of Cossack blood, from the Fursa family. She was a kind, sweet woman, but for all her love of peace energetic and wilful. She managed to do everything: to bring up the children, run the home, and to salt cucumbers that were famous and sold well not only in the neighbouring countries, but in distant provinces as well, in Libau, and Vilno, in Riga, and even in St. Petersburg! Once, coming back from the capital, Maria Moskalenko announced with great pleasure that an important personage—it could even have been a prince—had accepted a gift from her—a keg of choice cucumbers, and in return had promised to solicit for the Moskalenkos the title of suppliers to the court of His Imperial Majesty. In short, she had done not a little to build the reputation of the Nezhin's excellent cucumbers. And to be quite frank, their main income came from those pickles, from the barrels that stood everywhere in the yard, and not from Nikolai Moskalenko's shop. It was just a name. Look at Dyachenko's shop—now that was a shop indeed! The best store in Nezhin. The Moskalenkos, however, did not envy their neighbour. And their home, though modest and without the latest whims of fashion, not used to idle feasts, was clean and tidy, and there was always something to treat a guest to.

These days the guests came every Sunday. There were music, dancing and games—in short, young people. The senior son, Yuri, was already a student at the Institute of History and Philology, formerly Prince Bezborodko's Lyceum. And Maria was already quite nubile, and there was no end of suitors. Today was no exception, and Korolev was certainly going to be there... .

He had made up his mind to be there by all means although he was in no mood for fun.

There were several reasons for Korolev's bad humour. One of them was his job. This summer thirteen students had graduated from Prince Bezborodko's Institute. And there had been thirteen places on the list that had arrived from St. Petersburg from the Ministry of Education. Everyone was free to choose. Danilov chose Ekaterinoslav*. And what if Korolev also wanted Ekaterinoslav? Why should Danilov be favoured? He wasn't the best student, after all. So Korolev had gone to the director to claim the place. Danilov was backed by Sperantsky, the professor of Russian literature. No wonder, since Danilov was his favourite; he had published a collection *Songs of the village of Andreevka in Nezhin country*. What a prodigy! Three hundred peasant songs! Korolev had told Danilov frankly at the time: 'One should strive to create something serious and solid.'

That was a dig, indeed.

In fact, Korolev wasn't all that keen on Ekaterinoslav. What difference is there, if any, between Ekaterinoslav and Ekaterinodar**, which he chose eventually? His feelings were caused not so much by the choice as by pathological pride. Every time he was involved in anything, even something trifling, not worth bothering about, in which he could find or imagine an affront to himself, the muscles began to twitch angrily beneath the dark skin of his face. Everything seemed to him to reproach him with his low birth.

Pavel Korolev, the son of a retired regimental clerk, a reservist N.C.O. from Mogilev, had left the paternal home after completing his education in the Mogilev Seminary, where he had also been an usher. A church career

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* Now Dniepropetrovsk.

** Now Krasnodar.

promised him nothing interesting and his sharp and critical mind starved. So he had decided to enter the Nezhin History and Philology Institute, and was admitted in August 1901 as a student on a state maintenance grant. Scholarship students had even in Gogol's day been on full board, and didn't have to spend money on anything except soap. The self-supporting students, who paid their own way, were naturally better off. And it was then, incidentally, that Pavel Korolev was first made to feel the difference. And although he never resorted to the tobacconist Borts, who lent money to students at high interest, still he was not very well off even among the maintained students, and consequently felt dependent and suffered on that account.

But in studies there was nobody to rival him; every year he had been among the best scholars and took his degree in linguistics with only a single 'pass' in the history of Latin literature. On the 18 July, 1905, he was to receive the diploma with the long-desired line 'is entitled to teach in grammar schools'.

Pavel Korolev was in his twenty-ninth year, a staid age, and for some time had been making plans for his future. These days he inevitably came back in his meditations to the dark-eyed Maria, a damsel of rare beauty, the sister of Yuri Moskalenko who had just become a first-year student. It was already two years since he had visited her home, and he had had several chances to show his interest in her. But she seemed not to notice him. Sometimes she would look arrogantly at him, scan him from head to foot and laugh. Once, during the winter, on the skating rink, Pavel had even tried to propose to her, but Maria had escaped. And although her parents treated Pavel with the utmost sympathy, just the same he felt tension of sorts in her presence, and often turned suddenly around feeling that somebody was secretly laughing at him behind his back.

Today everything was as usual: poetry and songs, and the big gramophone horn already wheezing a waltz. The music annoyed him today, and all this gaiety, too. Today, more acutely than ever, he felt that he had outgrown this company, that he was bored among these eternally laughing girls and their smiling beaux. Music, music... . Look, ... Dohl, a student, also a philologist, had taken up a cello, and Maria Moskalenko was reaching for her violin. 'That's funny,' thought Korolev, 'where did she learn to play the fiddle?' Maria's younger brother accompanied them at the piano. Yuri's pleasant baritone rang out in the dining room, a student song of the Bezborodko Institute.

'We're all in love with the Institute in the first year. Just wait, in a year or two you'll hardly be in a mood to sing about the "beloved lyceum".' Yuri's youthful bravado and inexhaustible energy annoyed Pavel Korolev. 'There's that Alexei, the officer, with him again. He doesn't seem altogether indifferent to Maria,' Korolev thought.

Seeing Korolev Yuri shouted:

'Here's the man, who's going to judge between us! Pavel, do you think the battle of Tsushima is not only a military defeat, as our lieutenant thinks, but also a political one? I'm convinced the disturbances in the capitals bear that out...'

Korolev was not in a mood for political disputes; he cared little about Tsushima at the moment.

'Sorry, gentlemen,' and he raised his arms.

'Pavel Korolev is not eager to earn a reputation for disloyalty,' remarked the lieutenant nonchalantly, smiling with his lips only.

Korolev swung round quickly, his face muscles twitching again.

'After battles like Tsushima, my dear sir, I'm ready to distribute proclamations myself!' Korolev said firmly, deliberately looking the lieutenant straight in the eye, and turning sharply passed into the parlour. Still excited

by the encounter, he headed for Maria. She at once noticed the air of dogged resolution on his quick broad face, and in the way he awkwardly avoided her dancing sister Anna; and glancing into his widely set grey eyes, which were gazing fixedly at her, she knew that today the conversation she had so long successfully avoided, could no longer be put off.

'I must have a talk with you, Miss Maria,' he said in a low, but firm tone.

Maria Moskalenko said an unequivocal 'No' to Pavel Korolev's proposal of marriage. She had no thoughts, indeed, of marrying! It was only two weeks since she had finished school and she had decided to go to Petersburg in the autumn and enrol in the Advanced Courses for Women to study French. But everything turned out differently.

Having proposed to Maria, Korolev went to her parents. Nikolai Moskalenko listened to him attentively; Maria Moskalenko, his wife, shed a tear or two, made the sign of the cross over Pavel, and kissed him in the forehead. The offer was accepted. A family council was convened; the parlour was crowded with Moskalenko, Lazarenko, and Fursa uncles and aunts—all the relations were there. The decision was unanimous: Petersburg was not for Maria. Petersburg, just think of it! To go so far away, and alone! Where would she live there? And what about board? No acquaintances and no relatives—that meant she'd have to look for a *pension*. There would always be the danger of some good-for-nothing trifling with her affections. And what good are those courses anyway? There's the lady-doctor—she finished them. Well, what came of it? Every day she looks at naked men at the hospital. No, those courses are a lot of nonsense, don't let her go on any account! It's time she got married. The house is full of sui-

tors... . And the conversation came round again to Korolev. Maria ran out in tears.

They didn't rush her with promises, but mother and aunts were in a determined mood. Mrs. Maria Moskalenko looked forward to the wedding much more than her daughter. She had been dreaming of it for a long time and often pictured in the mind the yellow flicker of the candles, the crowns trembling in raised hands, the white cloud of the wedding veil, the splendour of the balanced voices of the choir. She had imagined everything down to the finest detail and prepared herself inwardly for the occasion, and now was unable to restrain her impatience.

'He's not good-looking, but what of that?' she reassured her daughter. 'The lieutenant is handsome, and that's no good. The only thing he cares about is whist. A rolling stone, he is. Here today his regiment is, but there's no knowing where it's gone tomorrow. Pavel Korolev is a solid, educated man. And he loves you.'

The aunts, too, nagged day in, day out. Maria held out for two months. One evening her father came in and patted her head.

'Well, Maria, I suppose your Mamma is right. Marry Pavel. You'll come to love each other. You'll have a husband, and a family, and life will go on.'

'Well, if you, too, Papa,' and she buried her face in his shoulder. Her father stroked her head, repeating, 'Life will treat you well, life will treat you well.'

As a former maintained student, who had to repay the cost of his board in the three years after graduation, Pavel Korolev was obliged to request permission to marry. Permission was granted on the 3rd of August, 1905.

The marriage register at the St. Nicholas Cathedral in Nezhin contains an entry recording the marriage of the teacher of the Ekaterinodar grammar school Pavel, son of Yakov Korolev, aged 28, to Maria, daughter of the merchant Nikolai Moskalenko, aged 17. They were married

at the cathedral on August 15th by the Rev. George Spassky. The groom's witnesses were his brother Ivan Korolev and a civil servant of the Mogilev provincial administration, Ivan Volosikov. The bride's witnesses were the Cossack Mikhail Fursa and the teacher Vasily Fursa.

The day after the wedding the young husband and his wife left for Ekaterinodar to take up his appointment as teacher of Russian in the boys' grammar school.

CHAPTER 2

The Korolevs spent one winter in Ekaterinodar. Korolev's absurd reluctance to go there turned into dislike of the town, and he tried persistently to leave. Toward summer he succeeded in obtaining a transfer to Zhitomir to teach Russian grammar and literature at the First Boys' Grammar School. Zhitomir had hardly any advantages over Ekaterinodar, but Korolev was calmed a little by his perseverance having produced results.

They took a flat on Dmitrievskaya Street (now called Levanevsky* Street) close to the school. In the autumn, when classes had begun, Pavel spent most of his time at the school. He made new acquaintances, and spent many evenings discussing the Japanese War, Tolstoy, spiritualism, and emancipation. The discussions were sometimes quite heated, and very liberal in tone. What a lot of these discussions, so beloved in the provinces of Russia, took place then all over the country—furious and vapid. They smoked, and that was not good for Maria, for she was pregnant. The long evenings of the melancholy wet autumn dragged on. The shutters of the house on Dmitrievskaya St. were closed early. Maria left a lamp burning only in the parlour and sat alone, reading or thinking about her life.

* After Levanevsky, a famous pilot, one of the first Heroes of the Soviet Union.—*Tr.*

Things weren't going well. Here in Zhitomir she finally realized that she did not and never would love her husband. Of course, he was a clever, educated, good man. And of course, he cared for her, though he was inordinately jealous. But what would that have mattered if everything about him displeased her, the way he walked, his eyes, his habit of tossing his hair back from his forehead, his stiff, straight moustache. She didn't love him. It wasn't understandable, or explicable—unloved. Everything seemed all right, only there was no love; so everything was all wrong. 'What holds my family together?' she would ask herself and found no answer. All her hopes now hung on the birth of her child, and she awaited it with impatience and fear.

Just before the New Year, on the night of 31 December, 1906, she gave birth to a boy. He was christened in St. Sophia Church. Pavel Korolev invited the godparents himself: a teacher, S. E. Bazilevich, and a neighbour, the wife of another teacher, S. S. Titova. The name 'Sergei' was entered in the register of births of the Volyn Consistory. That was how Sergei Korolev, a plump, shock-headed howler, made his appearance in this world. 'A new Chaliapin has been born!' his grandmother Maria Moskalenko joked.

Soon, having looked at her grandson to her heart's content, the happy grandmother left for Nezhin, and Maria Koroleva was again alone.

The young mother didn't have it easy in a strange town, where she had no relatives or friends.

Her hopes were not fulfilled; no change for the better took place in her family after little Sergei was born. On the contrary, Pavel Korolev became even more suspicious and jealous. She approved when he announced his inten-

tion of moving to Kiev. She was afraid of travelling with a baby in-arms, but Kiev after all was closer to home.

Sad news awaited them in Kiev: Pavel's father, Yakov Korolev, had died in Mogilev. Pavel was now the head of the family, and all its members, his mother, two sisters, and two brothers, looked to him for care and support. What were they going to do? It wouldn't be easy to feed a wife, a son, and his father's family on the salary of a teacher in Madam Beitel's Grammar School. Seven mouths. He knew what poverty was. Just as he was about, it seemed, to stand on his own feet and become somebody this had to happen. Once again he was being tied hand and foot and thrown back into poverty.

After his relatives had moved from Mogilev to Kiev Pavel Korolev became more and more embittered. That was understandable, what with the constant crowding in the tiny two-roomed flat, the timid hints that money was coming short again, the strident screaming and fighting of his twin sisters, the crying of his son, and his wife sitting there with a book in her hands.

'A book. Isn't that wonderful!' he would say bitterly, 'but wouldn't it be better to take the baby out for a walk?'

'But I've only just come in.'

He would turn away from her, restraining a fit of groundless anger for which he himself would feel sorry later.

'You've quite forgotten how to smile,' Maria said once to her husband timidly.

'I'm not up to smiling!' And he looked at her in a tired, indifferent way as if she were an inanimate object.

'What am I doing here?' she asked herself suddenly. 'Why am I living in this family? What keeps me at the side of this man who's an utter stranger to me?'

Her husband's mother did not maltreat her, having been quick to acknowledge her the mistress. But her sisters-in-law literally gave her no peace spying on her, and making it their habit to tell Pavel some tale about his

wife every evening. After Mrs. Moskalenko had paid a visit to her daughter they searched the whole flat for the money they thought she had left behind. The endless, humiliating checking of every item of the family budget, of every visit, of every conversation, of every step outside the house, all these digs, each unimportant in itself but very distressing taken all together, made Maria's life unbearable. Her desire to leave her husband's family, to break her bonds at one stroke and begin a new independent life, be it even harder, but with meaning of some kind and with prospects of a better future, grew day by day.

More than once she brought up the matter of the Higher Courses for Women in conversation with Pavel. He was categorically against. Maria wrote to her father. Old Moskalenko had already felt that they were rash in marrying off Maria. He felt sorry for his daughter. In a letter from Nezhin Maria found 50 roubles, the entrance fee for the courses. Her father wrote that he was prepared to pay for her studies. Disapproval of her husband could be read between the lines.

The courses only served to fan the flames of family strife. The family was breaking up before their eyes. Actually, it had broken down long ago, only they simply hadn't the courage to admit it.

At last Maria made up her mind. She took little Sergei to acquaintances and herself went to her sister. Anna was already reading the courses. Two days later brother Yuri arrived from Lodz and took little Sergei to Nezhin to his grandfather. Pavel Korolev was beside himself. He begged, entreated, and suddenly began shouting. Once he ran into her room quite out of his mind, the whites of his eyes shining, drew a pistol, and threatened and demanded that she return.

'Try and understand,' she said in a quiet, almost tender voice, 'I shall never return.' She felt unusually happy. It was the brightest day since her marriage.

A small, dark-eyed boy sat on the steps of his grandfather's house and smiled at the reflections of the sunbeams jumping from the spring puddles to the already dry, warm wood of the porch. He smiled, for he didn't know he no longer had a father.

CHAPTER 3

When Sergei Korolev was being got ready to enter the preparatory class at school he wrote a composition entitled 'Grandfather'. It was quite short: 'My grandfather was an old hunter. He lived in his own house. It had an enormous yard and a big garden. Grass grew all over the yard. There was a dog at the gate.' That was all. It was in this house, on the grass of that yard, that he spent his happy, solitary, strange childhood.

The only little person in the big house, he was at once his own master and his own slave. Everybody loved him: his grandfather and his grandmother, his uncles and his aunts, his grandfather's shop assistant—a lad of eighteen who had the additional job of yard-boy, and Varvara, Grandma's right hand in all household affairs, and her sisters, Anna, the cook, and Xenia, the maid, and the young school teacher, Lydia Grinfeld, and her old mother, Moskalenko's lodgers. Everyone loved him, but he missed the love of his parents at a time when he needed it most. He was always neatly dressed, always excellently fed, and always lonely, and nearly always sad. Everyone looked after him, and nobody cared for him. Everyone played with him, but he liked most of all to climb up on the high roof of the shed on the left of the wicket gate (which was always locked) and watch the teams of lazy oxen draw their carts slowly along the street toward the market square. He was never allowed outside the gate; those were his mother's orders. She was afraid Pavel might kidnap Sergei in his fury. The boy didn't know how people lived on the

other side of the fence. Actually, he did know something: for instance, that beyond one fence there lived the rich Ryzhkovs. They had no children, and it was always quiet there. Over the other fence was the Livadia Hotel. There was always a bustle and commotion there, but never the sound of children's voices. After the bustle of Kiev, Sergei at first thought life rather dull in the silence of the house and the stillness of the garden, but in time he grew used to it and did not suffer from loneliness. When Lydia Grinfeld, the teacher, came back from school, he would call out to her from the far room: 'Is that you, Miss Lydia? I'm glad you're back.' But he wouldn't leave his room and would continue playing inside. He spent hours sitting before a big box of bricks that Uncle Yuri had brought him from Lodz, and a whole town with a tall cathedral, big-pillared houses, and shops and bridges would rise in grandfather's bedroom. In winter he went tobogganing in the yard and zealously built snowmen with charcoal eyes and carrot noses. But always he was alone. During those hours he never became fretful because he was bored of playing in this way; on the contrary, he never felt bored since he knew nothing of the usual gaiety of children's games. Many years later, when a student, he used sadly to say: 'I had no childhood in the strict sense of the word.'

True, his first year in Nezhin was spent with his mother. Maria Koroleva realized that she must wait a little with her courses; the boy was still quite small. Then she went away, and he was left alone. Now Mummy only came on Saturdays. Oh, that was a real holiday! The gate was flung open, and they went out for a walk. In summer, they went far far away to such distant places as the river and the market that could not even be seen from the shed roof, and afterward sat in the Gogol public garden; Mummy sat and he roamed the paths and alleys, running round the old lamp-posts near the monument, and swung on the

heavy chains around it, squinting up at the mournful bronze face of the man with the long thin nose.

Wasn't it wonderful when Mummy came home!

In the evening they sat together on the broad pillared porch, and she read all sorts of books to him about the magic tablecloths, and flying carpets, and the naughty little Hunchbacked Horse. Mummy would read till dusk fell. A huge yellow moon would rise over grandfather's garden. Mummy would lay the book aside and go on with the story. These were stories of her own, and they were more interesting than the books. Then grandmother would call them in to tea in the dining-room. Now everything—the garden, the moon, the whole world—was shut out behind closed shutters. The samovar, glittering warmly in the yellow light of the big paraffin lamp, was humming its song on the table. How he loved those Saturday tea-parties with Mummy!

Maria Koroleva, not so long ago a teenager herself, was fond of the heroes of Fenimore Cooper and Mayne Reid, and did her best to bring her boy up to be courageous and manly. She would send him specially to distant dark rooms, or out into the night of the garden for some trifle, and he would go meekly, looking around constantly and fighting back his fears.

Little Sergei also loved Uncle Vasily who had a reputation for generosity and really loved his nephew. He would take Sergei for rides on his bicycle, play croquet with him, show him an ingenious device, his camera, and once even let him press the shiny button on the end of the cable. There was a dry click in the camera. His older uncle, Yuri, who brought the bricks from Lodz, was also a jolly, lively person, but he didn't play croquet. Friends used to come to visit him, and they engaged in long arguments about incomprehensible subjects. Uncle Yuri's voice was the loudest of all; he took things very much to heart. There was some sense in Grandma's joke that Yuri could per-

suade the stove to change its corner. Once when they were hard at it, a police inspector knocked at the door. Grandma went to let him in and was heard laughing without humour in the hall and inviting the inspector to the birthday party—though little Sergei knew positively that there was no such party. The inspector went away, and Grandma returned looking rather grave.

Sergei grew up quickly, surrounded by grown-ups and their preoccupations and conversation. Port Arthur was mentioned frequently at the table. Once Sergei burst into the room with a merry yell, waving a toy sword:

'Granny! Victory! I've knocked all the Japs' heads off! Come quick!'

Red peony buds were strewn all over the garden paths. Granny looked down at the decapitated flower-bed and sighed deeply.

Toy soldiers took the place of the bricks. Sergei learned to read early; no one noticed just when and how he did it. At five he already wrote in block letters and read books. His earliest surviving autograph dates from 1912 when he made his uncle a present of his photograph and wrote on the back: 'To dear Uncle Vasily from Sergei'. Nearly all the letters and the date were written as mirror reflections. His mother asked Lydia Grinfeld to coach the boy for the first form of the grammar school. He studied willingly, and was especially fond of arithmetic, and was good at mental arithmetic, solving short problems orally; he learned fables and verses by heart, and loved to retell stories from a series *The Heart-to-Heart Word*. When Miss Grinfeld read fables to him he would sit perfectly still. Afterward he would ask: 'what's a godfather?' She would explain. 'What does a "prophet" mean?' Now everything was clear, and he was satisfied. Despite his isolation from other children and confined way of life, he was neither unsociable nor awkward, nor a slow thinker; on the contrary, he was very active and quick, but he had poise that was

somehow not childish and that seemed to inhibit any wild traits in his character.

Perhaps the clearest memory of his life in Nezhin was Sergei Utochkin's flight in the summer of 1913. The famous aviator, who for several years had been making public flights in Russia and abroad to popularize achievements in aviation, made a stop in Nezhin. The town seethed with excitement. Groups of people stood round the posters discussing the future unbelievable performance, a performance so miraculous that nobody grumbled, as usually happened, about the cost of the tickets—one whole rouble. By three o'clock in the afternoon on the day of the flight the fair ground, where the biplane had been brought from the railway station, was surrounded by people without tickets. Urchins clustered on the trees and on the roofs; soldiers of 44th Artillery Brigade, which was stationed in Nezhin, sealed off the grounds for decent folk.

Sergei arrived at the fair ground with his grandfather and grandmother. Mrs. Moskalenko was fond of every kind of technical novelty. She had already more than once travelled by train; in Libau an officer, an acquaintance of hers, had shown her a submarine, and even taken her inside the terrible thing. She wouldn't miss an aeroplane flight for anything. Sitting on his grandfather's shoulders Sergei saw a short, resolute, ginger-headed man walk toward the biplane, and climb into it, and heard him shout something loudly and sharply to a soldier standing by the propeller. The soldier turned the blade, the aeroplane started rattling and shaking with twenty or so soldiers holding its wings and tail. The cloud of yellow dust raised by the propeller swept toward the boaters and parasols of the well-dressed public. The crowd stirred slightly, but remained, uncomplaining.

The engine was warmed up for about half-an-hour. At last Utochkin waved his arm, the plane roared wildly, and the dust rose in a whirlwind so that Sergei could hard-

ly make out the shapes of the soldiers in the yellow cloud. Then the aeroplane began rolling jerkily over the ground at ever increasing speed. The soldiers ran with it for a while holding the wings, and then they stopped. And then the plane flew! Sergei saw how it hopped at first, hitting the ground lightly with its wheels, then rose... and flew! A wave of excitement swept through the crowd. Listing a little the plane gained height and was already some fifteen metres up.

Utochkin flew a kilometre or two and landed in a field near the retreat buildings of the nunnery. The crowd rushed to cheer the hero, and Sergei and his grandfather and grandmother went home.

At tea that evening conversation was only about the flight. Grandma criticized the aeroplane and recalled the balloon that had made an ascent in Nezhin twenty years before from the yard of the Czech Jans' brewery and landed three streets away on Millionnaya Street. She well remembers how the aeronauts jumped out of the gondola straight onto a tree in the Pocheka's garden! Now, that had been a flight!

In the autumn of 1960, when choosing pilots for his cosmonaut unit, Korolev suddenly—and so very very clearly—remembered ginger-haired Utochkin, and that sunny day long ago, and the pungent smell of the yellow dust.

Toward the autumn of 1914, just after the outbreak of the war, it was discovered that the Moskalenko's finances were in great disarray. New energetic people with special machinery had entered the pickling business, and its pattern was changing from a cottage industry to a factory one. How was Mrs. Moskalenko to catch up with those capitalists? She hadn't the strength. Trade became slack, so it was decided to liquidate the business as quickly as possible, and sell the shop and the house. In recent years the

house had become rather too big. Its rooms, not so long ago noisy and gay, had suddenly become unusually empty and quiet. All the children had flown away: Maria and Anna were studying in Kiev; Vasily had already graduated and was also in Kiev. And Sergei was bored in Nezhin. And now there was the war, God save us and protect us.

Vasily had taken a flat on Nekrasovskaya Street. With great bustle and much ado they got their belongings together, loaded them up and moved in on him to begin life over again as one big family. Everything was as it used to be; even Varvara, true soul, and Anna, the cook, were there. Yet it was quite unlike their happy life in Nezhin. The flat was too small, and lonely without business. The children were not the same, they were grown up now and independent. And the city strange, big, and noisy. And the big, noisy, quite unfamiliar life penetrated the walls of the new flat, bringing with it cares never before experienced; and there was no getting away from them.

The first war hospitals had already been opened. Anna was working as a nurse, dressing wounds, on night duty. Once she took her sister with her. Maria Koroleva sat all the night beside a dying subaltern. He was delirious, shouting scraps of abuse, then falling silent, soaked with sweat, throwing himself back on the pillows and begging for water. Toward morning he smiled at Maria and said, 'I never thought, sister, that I was so strong. Death can't get me.' In an hour's time he was taken away to the ward for the dying and the doctor said to Maria: 'I see you're upset. I advise you not to come any more. You're an educated woman. You will be able to do some other service.'

Maria studied and worked in the college office. In return she was exempted from tuition fees, and in addition paid twenty roubles. But the family was nevertheless short of money. Prices rose like mushrooms. Varvara was outraged:

'Even bread and potatoes are twice as dear!'

On the Kreshchatik, the main street of Kiev, there were disorderly noisy 'patriotic' demonstrations: 'For Russia, for victory!' But the workers were on strike. Those who expressed dissatisfaction were conscripted into the army, and their places filled by prisoners-of-war. There were Germans working at the Auto-works, the Arsenal, at Greter and Krivanek's, and at Filvert and Dedina's*. Resentment was building up in the industrial quarters of the city. Leaflets appeared. From the front came alarming rumours: the army was in retreat, the military failures of the spring and summer of 1915 got worse, and bared the contradictions in the rear. It was hard to believe that there had, not so long ago, been quiet green Nezhin, tea-parties behind closed shutters, and the excitement of Utochkin's flight. It was another world.

No one had much time for Sergei. His mother later sent to the archives of the USSR Academy of Sciences a short note that he wrote them, which showed him as an observant boy, and which to some extent characterized the atmosphere of his life in Kiev.

'My Views on Auntie Anna
A bad day for Auntie Anna

Auntie Anna got up grave and gloomy. She doesn't laugh any more as gaily as on a good day. She leaves for her lectures. She comes back tired and dissatisfied, eats her dinner in silence, and goes off to lie down. Having rested, she goes out again, sometimes to a lesson or to a lecture. And returns darker than a cloud! I'm afraid to say a single word.

S. Korolev

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* Large Kiev factories in which in 1915 there were 1239 German prisoners-of-war working.

A good day for Auntie Anna

I come in to my Auntie in the morning, and she greets me affectionately, laughs gaily, and kisses me. Later in the day she reads and after dinner she talks! I play games and cards with her, and lie on a sofa and talk. Sometimes she helps me to glue and to make all sorts of things. A good day is generally better than a bad one.'

He always had something to do: colouring pictures, gluing models, collecting stamps, playing with toy soldiers, building bridges with wooden bricks. And once Grigory Balanin brought him several coloured balloons.

Sergei had become acquainted with Grigory Balanin a long time ago, before he left Nezhin. Mummy had taken him to Kiev to have his tonsils operated on. They were met by a tall stately man about thirty years old, with a nice, rather long, face and serene clear eyes. That was Grigory Balanin.

When Maria Koroleva was studying in Kiev she rented a room in Fundukleevskaya Street. The landlord had a dull son, and Balanin was coaching him in mathematics. That was how Maria met her second husband.

Balanin was an interesting person. The son of a forestry inspector, he had gone to a country school, then to a seminary for teachers, which, to his own astonishment, failed to discourage him from further study. He had gone to Petersburg, where he had managed to enrol in a teacher training college. The years he was obliged to work to repay for his maintenance grant he had spent in Finland and Karelia; there he had saved some money and had gone to Germany. From Germany Balanin returned with the diploma of an electrical engineer and a brilliant knowledge of German. But the German diploma was not considered adequate in Russia, so to get a Russian engineering degree Balanin enrolled in a third institute, the Kiev Polytechnic

founded in 1898. When he met Maria Koroleva he was *in statu pupillary*, but there was little of the student about him; he was an adult, well built man, and an excellent engineer, unable, however, to prove it by work. He only got his degree in 1913.

In that year Sergei, awe-struck by the severe white purity of the Kiev hospital, where, as he guessed from his mother's special tenderness, something unpleasant was going to happen, could have no idea of the important part Balanin was going to play in his life, of the good he was going to do to him, and of the grief he would cause him, or that he would become his older comrade for many years to come. This was only their first acquaintance.

In Kiev Balanin frequently visited the Moskalenkos. Later he went to Petrograd, then to Borisoglebsk, and then to Tambov and Voronezh gubernias, where he was consultant in the building of the first grain elevators in those provinces. Finally he returned to Kiev, leaner and more mature. The very first evening he visited the Moskalenko flat. A few evenings later Grandma explained to Sergei that his mother was marrying Grigory Balanin, and that from now on he, Mummy, and Grigory Balanin would be one family.

'And you?' asked Sergei.

Grandma smiled.

With the cruel adolescent egoism of all boys of his age, Sergei felt a sudden dislike for Balanin. This was the destruction of the world not only of his grandfather's house, but also of people who inhabited it. Children are conservative. He didn't want any changes. Let Mummy and Grandma, and tired Auntie Anna, and gay Uncle Vasily always be close to him. He didn't need anyone else. Anyone else would disturb the normal harmony of the family; he felt it intuitively, and intuitively struggled against the coming changes.

But it was beyond his power to prevent them. Maria

sued for a divorce, but Korolev stubbornly resisted, and the case dragged on. Soon she and her sister Anna left for Saratov where the Higher Courses for Women had been evacuated. That was the beginning of the hard, hungry, uncertain period of the 'ordeal'. Sergei was again left with his grandmother.

If Maria Koroleva had not left Kiev, these amusing and touching letters of a boy in between childhood and adolescence would probably never have been written:

> 'I was bored on February 28, and I am not very jolly now; learning is hard... . Dear sweet Mama, I'm going to make cream on March 25*. I'll buy 90 kopecks worth of sour cream with my own money and have a treat. Uncle Yuri promised me a rouble. The weather's bad sometimes, then good... . It's very, very hard for me to study. To learn divinity and arithmetic... .
>
> 'Dear Mama I do not miss you and I ask you to write how your health is because you are not well in my dreams... . I ate pancakes for you and had eight, and before that five... . I've glued an aeroplane together, it's very beautiful... .'

Mama returned towards the summer. The divorce proceedings were finally heard. Pavel Korolev asked for custody of his son, but the court refused. In November 1916 Maria Koroleva married Grigory Balanin.

At the beginning of 1917 Grigory Balanin was transferred to Odessa to the staff of the South-western Railway. On April 26, 1917, Sergei wrote to his stepfather:

> 'Dear Papa!
>
> 'Mama and I are well. I'd very much like you to make me a trapeze. Mother is getting ready for her

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* His mother's birthday.

exams, and so we shall leave on the 15th or 16th. I'm taking art and draw nice pictures... . Only, please, if Mama fails her exams, don't be cross. I shall soon be in the first form and will come to you a first-former... .'

Maria Balanina and Sergei arrived in Odessa toward evening. While their cases were being unloaded at the house, Sergei looked in the direction where, from what they had told him, the sea should be; but he saw nothing except yellow windows behind which lamps were already being lighted. In the morning he woke early, remembered quickly where he was, and creeping softly, and raising the handle to prevent the door from creaking, slipped out into the street. He walked quickly, then started running. The morning was cloudy, and there was no sun. A bright, boundless blue expanse extending freely in all directions opened up in front of him. For the first time in his life he saw the sea. A strong wind, breathing freedom, blue in gusts. Sergei shivered, but didn't leave, staying on and on staring. Suddenly he began to laugh without knowing why. He laughed because he saw the sea, because looking at that expanse he felt with all his being the vastness of his future life, and believed in its coming delights, in all the still unknown, but marvellous and beautiful that lay before him.

CHAPTER 4

Some time later Balanin was appointed head of the port power station. At first they took a flat on Kanatnaya (Cable) Street, but soon they had a chance to move nearer to the power station, and they settled in a spacious flat in a two-storeyed house on Platonov Pier, with a balcony overlooking the sea; below the balcony bloomed lilacs among oleanders.

Literally from the very first day of their life in Odessa the port engineer's little family was drawn into the whirlpool of events that were breaking up all the accustomed way of life of 'Mama Odessa'.

No other city, probably, experienced as many upheavals in those years as befell the lot of Russia's big southern port. Power was mixed and uncertain: the organs of the Provisional Government did not recognize the Soviet of Workers' Deputies, and the Soviet, in fact, did not recognize the Provisional Government. In May 1917 Rumcherod came into being, the Executive Committee of the Soviets of the Romanian Front, the Black Sea Fleet, and of the province of Odessa. Balanin went to the debates and returned in a sombre mood: no 'victorious end' was in sight, only talk and cackle.

'The Bolsheviks won't put up with them, I think,' he said to Maria. 'You watch, there's going to be a mess.'

In December the Second Conference of representatives of the Romanian front opened. The Bolsheviks were in the majority. The situation became tense. Clashes and fights broke out here and there, and any minute they could turn into a real battle.

The city entered the new year, 1918, with expectations of unprecedented changes. Armed soldiers of the Akhtyr Regiment, sailors from the *Sinop**, and workers of the Red Guard marched through the streets.

On January 14 shooting began in earnest. The officer cadets and the haidamaks** held out for two days. Street-fighting subsided, then flared up anew. The Third Boys' Grammar School, which Sergei had entered in the autumn, was shut for an indefinite period. A youthful, very well mannered inspector brought pupil Korolev's papers to Pla-

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* The Akhtyr, machine-gun, and cavalry regiments of the Odessa garrison and the sailors of the *Sinop* supported the Bolsheviks.

** Ukrainian counter-revolutionaries with nationalist views.

tonov Pier. The former pupil now sat at home under strict orders from his mother not to go beyond the port gates; but even from there he could distinctly hear distant shots ringing over the sea. And one day he saw a grey leaflet hurriedly pasted onto the wall of the power station: 'To all the working people of the city of Odessa'. Soviet power had been established.

Now schools were opened. No longer grammar schools, but schools. But Sergei didn't study for long; in six weeks' time Austrian and German troops entered Odessa. Sergei saw a tall German officer strolling through the port inspecting the berths in a business-like manner, asking questions about depths and anchorages, and writing things neatly in a notebook. Balanin acted as interpreter: his knowledge of German unexpectedly became needed.

Officially, the Germans recognized the Ukrainian Central Rada, but that did not prevent them from behaving as complete masters of the city. The occupation proclamations threatened open terror. Bustling Odessa seemed to be dead. Sergei pined at home. That summer he became addicted to books. He entered that unavoidable phase of unsatiable reading that every boy sooner or later experiences. Only at ten can a person read so avidly, and so unsystematically, swallowing everything in pure and hot, drinking in everything, and taking everything to heart. Sergei read a textbook on geometry, Chekhov, then Hauff, then an odd volume by Reclus, then a romantic novel without a beginning, Nadson's verses, and manuals on the strength of materials.

The Germans and Austrians left in November. Sergei heard Balanin tell his mother that Field Marshal von Beltz, the commander of the Austrian garrison, had shot himself. The Germans were gone, but it was too early to rejoice. On November 26 the British destroyer *Nerenda* appeared off Odessa. Three days later the first lot of Serbs landed, followed by a French landing party. The gay Frenchmen landed in the port with their greatcoats tucked up under

their belts, rocking with laughter. Sergei and his stepfather were standing on the balcony. The cold wind from the sea ruffled Balanin's hair. He was chilled to the bone, disturbed, and quite helpless. He turned toward Sergei, and the latter saw how sad his eyes were.

'New bandits come to take the place of the old ones,' he said loudly.

He was right. A new period of counter-revolutionary excesses set in, perhaps the wildest and cruellest. That spring the Bolshevik hero Nikolai Lastochkin, brave Jeanne Labourbe and her comrade in the 'Foreign college' Jacques Elin were killed. The winter of 1919-20 was very hard and hungry. Maria Balanina gave Ukrainian and French lessons. In payment she received a pail of unbearably salty barley gruel, but everyone was overjoyed: there was no salt. To get salt one had to go to Hadjibei, dig a hole, pour sea water from the lagoon into it and then wait for the water to dry. Everything had been eaten up in Odessa. There was no food in the city. From time to time bay leaves would be on the ratio. The markets were crowded. Everyone was selling everything, but there were few buyers. Values changed; a fur coat was offered for half a sack of flour. But often there was no one to take it. People made trips to the villages, to the rich German farms, to barter things for food. Once Sergei tagged along with his mother. They went out to Vapnyarka, and had wonderful luck. In one village they were able to get a sack of potatoes; but they hadn't the strength to carry it home. Maria Balanina felt she was going to fall, and she let the sack sink to the ground. Sergei shouldered it, took a step, stopped, and swayed on his widely planted feet, stood still for a moment, and went on. He ground his teeth, but trudged on. Suddenly his back felt quite light.

'Let me have it.'

He turned round and saw a strange man. For a moment Sergei thought he wanted to steal the sack, but then he saw that there was no greed or malice in his eyes.

'It's no good putting such a load on a lad,' the man said in a hoarse voice, and shouldered the sack.

Maria Balanina said nothing. When they got to the station she wanted to give him some potatoes—the stranger was hungry, and she had noticed it—but he refused.

They paid a box of matches for their night's lodging and in the morning set off for Odessa in a crowded smelly coach of the local train. Sergei felt hot and thought it was because of the crush and the stuffiness. His head spun. 'I must get outside, and everything will be all right,' he thought.

But it wasn't better. He had typhus. That winter the whole family was sick, but they all pulled through and greeted the spring and the new green grass. There's nothing sweeter in the world.

In April 1919 the French sailors mutinied. The spirit of the *Potemkin* descended on the interventionists' squadron, and Paris was in panic. Orders were received to evacuate troops from Odessa. From April to August the Soviets made timid efforts to rehabilitate the shattered, starving, half-empty town. In August it was occupied by Denikin's men. Tired and worn out they staged drunken orgies and senseless round-ups, shouting 'Death to the Red bandits', but themselves were already dead and done for. Ships sailed from the docks with crowded decks and headed for Istanbul on a bitter, dreadful, one-way voyage.

On February 7, 1920, Soviet power was finally established in Odessa. This time for always. But it took much time for the thin skilly, the outbreaks of cholera, the rags on people's backs, and the motionless cranes of the docks to become things of the past, and for people to forget what Konstantin Paustovsky, a young reporter from the Odessa *Seaman*, described in 1922 as 'a time of hunger, rationing, and wild winter nights on the streets of Odessa'.

This historical excursion, though it interrupts the story of Sergei Korolev's life, seems worth making. Those were

not easy years for the grown-ups and quite hard for the children. The storm of the Revolution turned the leafs of the calendar so fast that the children of those days grew up at a rate that seems incredible today. Of course, at ten to thirteen Sergei Korolev remained a child, but alongside and within his boy's life, there were cares that were quite unchildish, and problems loomed that were not boyish.

His concepts of good and evil, of courage and cowardice, of justice and injustice did not spring from the tales he had heard in Nezhin, but grew from what he saw before his eyes. Grigory Kotovsky was a hero he saw not only in films, but someone he may have met in the streets of Odessa. Nikolai Lastochkin was no bronze monument of an abstract hero of the Civil War for Sergei; he may have seen him in the port as the White-guard butchers led him bound and beaten to the barge they had converted into a prison. Many years later people marvelled at Korolev's exceptional faculty to see the essence of a man. Was it not there, in Odessa, that the roots of this rare talent are to be found? Those grim years freed his eager mind from the hallowed canons of pedagogics and naturally affected his education. But they enabled him to see things for himself and form his own ideas about the vast and intricate panorama opening before him. And they accelerated the process of choosing his sympathies and passions, of developing his tastes and propensities, in short, they speeded up the formation of his personality. So when all that was completed, more or less, at the age of 16 or 17, it is no wonder the boy was already a grown man.

But just now he is still a boy. He wears the knees of his old trousers out crawling all over the floor with his friends among his tin soldiers. One winter they tried to teach him the violin, but his mother soon understood that her son had no talent for music. He likes building and handwork best. He collects planks and chips, pieces of sailcloth and

lengths of wire, and brings them home to make toy steamships and sailing boats. When the Seamen Union opened a Harbour Club, Sergei was quick to join the model ship circle.

Life on the coast made him fond of the sea. It remained vast and terrible, but it ceased to be strange, incomprehensible, and alien. It didn't take Balanin long to teach him to swim. Sergei swam very well; he never fought against the sea, so it always helped him.

Sometimes he and his friends went a long way off to the Arcadia Rocks where one could jump and dive to one's heart's content; but usually they bathed at the Austrian beach—a stretch of sands the Austrians had used as a sand-pit.

Sometimes, when swimming in the harbour, they climbed aboard ships, and considered it very *chic* to tease the bosun, and then run away from him in mock terror, and at the very last moment, as his great paws were about to grab their ears, to swallow-dive into the green water.

Sergei was an excellent oarsman. Once the boys rowed far out to sea, beyond the lighthouse, and Sergei, who was sitting in the bow, saw something big, dark, and slippery rolling heavily in the light waves just ahead. Though he couldn't yet make out the neat horns that showed for a second as it wallowed slowly in the water, he knew what it was—a mine!

The boat was heading straight for it. His voice stuck in his throat.

'Back water!' he screamed as he fell out of the boat. He surfaced instantly and pushed against the bow with all his might. And felt his back touch slippery cold metal.

He came home pale, and frightened, and subdued; and it took him long to get over that encounter with death. They met more than once again in later life, but the fear always came afterward and could never strangle him, never freeze his mind.

CHAPTER 5

In the summer of 1922 a rumour spread through Odessa that a new school was to be opened in the building of the old Second Girls' Grammar School. It was to be an educational establishment of a new type, unusual and wonderful. No one, in fact, had any clear idea of its programme. Its hear-say popularity was due primarily to the fact that the names of people, well-known and respected in town, had been appointed to the staff.

The Revolution, being itself a great historical experiment, produced a thirst for experimenting in the minds of active and talented people. It was impossible to go on living and working as people had lived and worked before. The search was going on everywhere—in politics, in economics, in art, and in literature, and the world of teaching could not remain unaffected. And that, in fact, is how Odessa Building Vocational School No. 1, where Sergei Korolev studied, came into being.

The leading spirit of the school was Alexander Alexandrov, a grammar school teacher, a gifted pedagogue and an extremely energetic man. The school he planned was to provide a general secondary education, on the one hand, on the lines of the classical Russian grammar school, and, on the other hand, by introducing several special disciplines to train pupils for such building trades as plastering, tiling, plumbing, carpentry and brick laying. It was the prototype of modern-day Soviet specialized technical secondary schools, but of a higher standard coming close to that of the first years in civil engineering colleges. So there were several university teachers on the staff: Prof. B. L. Nikolai, an eminent scientist from the Odessa Polytechnical Institute, taught strength of materials and building mechanics; the course in Russian language and literature was read by Prof. B. V. Lupanov, the Head of the chair of Latin at the Medical Institute and a connoisseur of European literature.

Mathematics was taught by Alexandrov and by a senior lecturer from the Building Institute, F. A. Temtsunik; while physics and theoretical mechanics were taught by V. P. Tverdy, a senior lecturer at the Polytechnical Institute; and civil engineering and building by S. A. Todorov. Many buildings in Odessa used to carry plates proclaiming: 'Built by Todorov'.

The aesthetic education for the pupils was one of the main concerns of the organizers of the school. Debates, amateur dramatics produced quite professionally by a great connoisseur of the theatre, the literature teacher P. S. Zlatoustov, choral singing, a course in Greek drama read by B. V. Lupanov, concert-lectures on the history of music by B. D. Tyuneev, a professor at the Conservatory, and the gifted pianist and composer, P. I. Kovalev, dancing classes, art classes with the painter A. N. Stilianudi, a pupil of Repin and friend of the artists Serov and Vrubel and the poet Pasternak—all this was normal at Vocational Building School No. 1.

In short, it was a very interesting school. No wonder Sergei Korolev wanted to study there, or that his decision was warmly supported by his mother and stepfather.

Sergei passed the entrance examinations without difficulty and was admitted in July 1922.

A mysterious new world opened before him. The elevated, major-key spirit of the school, with its slogans 'Long Live Freedom!', 'The Whole World Is before Us!', 'Study, Work, and Fight!', 'Mathematics Is the Key to Everything!', the atmosphere of trusting equality, and the spirit of democracy pervading the newly established traditions and rules—all evoked a warm response in the spirit of young Korolev; and all his life he remembered with affection and gratitude the brief time he spent within its walls.

Among his class-mates was one Valerian Bozhko, or Val for short, with whom he had been friends all those hard years. Now they shared the same double desk. This very

modest, quiet, tall, incredibly thin lad had had his right arm torn off below the elbow during the war. He wrote and drew skilfully with his left hand, loved, and was clever at, making things; it was probably only in gymnastics that he could not share Sergei's enthusiasms. A close circle soon drew together in the class: Sergei, Val, jolly Ilya Yoffik, George Kalashnikov, a typical Odessa 'yobo', and clumsy, short-sighted Vladimir Bauer, famous for his ability to recognize people with his closed eyes from their smell.

It is only by chance that Sergei first got into this list. All his old class-mates are unanimous in later years in saying that he was quite unremarkable figure at school. He was never part of the class élite, and never first in anything: he wasn't a 'shock worker' (Nadya Khlebnikova, Prof. Temtsunik's favourite, literally worked wonders as regards progress and application), wasn't the 'life and soul of the party' (those laurels went to Ilya Yoffik), hadn't a reputation as an outstanding sportsman (Kalashnikov was undoubtedly a better gymnast), didn't shine on the school stage (that was the domain of George Nazarkovsky, a boasting dandy), was no musician (Yuri Vincentini and Lydia Gombkovskaya played the piano well). His mother remembers him writing poetry, and she thought one of his poems, *Russia*, quite good at the time. The notebook of verses had disappeared: one of his friends made a crude joke about his 'poetic experiments', and Sergei burned it. But nearly everyone writes verses at fifteen. So he gave the impression of a typical average pupil, not remarkable for anything except, perhaps, his good looks: he had black eyes and a soft girlish blush on his cheeks. It is amazing, but even if he felt superior in anything, Korolev was unable in his youth to show it to effect. It was difficult to rouse him. The solitude of Nezhin had made him, if not secluded, at least unsociable. He was not secretive, and if a question was put to him he would answer; but he wouldn't start talking himself. And yet there was something about him,

some quality that everyone instinctively felt, that made it impossible to relegate him to the class of colourless people. Otherwise it would be impossible to explain why in everything they got up to, every prank, every party, every outing, debate, and competition of all the clever boys, the champions, the wits, and all the other recognized talents, there was a place for him and his presence was a 'must'.

In the first school winter of his life, there was no light, no paper, no fuel. There was no coal and no wood. They sat in their overcoats in class, and even then it was cold. The slang name for the coats was 'fish fur'. Everyone's clothes wore out in those years, and people walked around in God knows what kind of dress. Sergei's mother herself even learned to make shoes.

In 1923 Alexandrov who was only director of studies, but to whom the head of the school, a leading Odessa architect, V. I. Bortnevsky, had in fact relinquished his powers, took it into his head to set up a workshop at the school to make things for sale. The idea was that unsophisticated things, made by the pupils with their own hands, could be sold, and the profits used to supplement the meagre school budget.

Everything had been planned and considered, and the premises had been found; the only thing left was to find tools and machinery. In 1923 that was a very real problem: every file was worth its weight in gold. Alexandrov put pressure on the Education Department, looked for good patrons among the factories and in the port. Everyone agreed with him, his ideas were warmly approved. However, nobody gave any tools. But just at that point he learned quite by chance that a joiner's shop in the Moldavanka area of the town was being sold.

Konstantin Vavizel, the owner of the shop which made wooden pulleys, agreed to sell his 'business' to the school. 'But only on one condition, young man,' the old carpenter told Alexandrov. 'You'll have to take me too.'

So, at one stroke the school got a craftsman instructor and the tools. And they were a treasure: a band-saw, a circular saw, a lathe, workbenches, planes, chisels, and hammers! And a small electric motor and transmission belts to drive them. The belts were often torn, of course, but what did that matter?

The whole school helped to move Vavizel. It was a wonderful jolly day. And it was followed by the arrival of firewood. Again the whole school turned out to unload it, and with great care: smooth logs without twigs or knots were put aside as stock for the workshop.

Sergei became one of old Vavizel's favourites. The joiner trusted him and knew that he was an earnest, tidy lad who didn't break things. Sergei used to stay late in the workshop. He liked wood-work, and then he had to help Val Bozhko; you can't do much with a plane with one hand.

In the spring, with the coming of warm days, everyone cheered up a bit. Everybody had hurried home from the icy school, but now no one wanted to leave. Sergei liked it there, and he took an interest in his studies. They were being taught the elements of higher mathematics, of building mechanics, and of strength of materials. Experiments, albeit simple ones, were performed (they had no instruments for more sophisticated ones). Prof. Tverdy devised one that seemed very simple: a board was laid across trestles and loaded with bricks; its sag was measured and Young's modulus for wood calculated. Prof. Lupanov arranged literary debates: Katya Maslova, Bazarov, and Raskolnikov were picked to bits, judged and defended. Korolev seldom raised his hand, but when asked gave a coherent answer. Once the physics teacher gave out a flock of fails: even the best of the best were unable to draw the circuit of a telephone and explain how it worked. He called on Korolev. Everyone was convinced that he too would be failed; but Sergei drew the circuit on the blackboard without undue haste and ex-

plained everything. Everybody was astonished, and George Kalashnikov said: 'You're our Edison, Sergei.'

But, of course, he failed to get passes, too. When he didn't know the answer, he didn't try to dodge, but said gloomily: 'I don't know.' After such a confession it was against all the laws of teaching not to fail him.

In the spring the boys developed a new passion—yachts. Odessa had always been famous for its yachts, but during the Civil War, of course, there was no yachting. Many of owners of famous yachts fled abroad leaving their beauties to their fate.

Now enthusiasts organized a voluntary naval cadet training centre in the port. They took over the yachts, patched them up and re-named them in the spirit of the times. The *Mayana* became the *Lieutenant Schmidt*, the *Meymon* the *Communar*, the *Vanity* the *Komsomolia*.

Now Kalashnikov, Bauer, and Korolev ran straight from school to their yachts in the former Arbuznaya (Watermelon) Haven Kalashnikov sailed *Irene*, Bauer *Meteor*, and Korolev *Lieutenant Schmidt* which every one, including its 'godfathers', continued to call *Mayana*.

Before the Revolution the *Mayana* had been owned by one Faltzfein, the owner of canneries and of an enormous estate, which has now been converted into the famous Ascania Nova reservation. The *Mayana* was a magnificent yacht built in England in 1910 by Milnes, one of the best yacht designers, and had won many international races. Korolev sailed it often, and when the wind was fair the yacht ran as far as Nikolaev, Kherson, and even to the coast of the Crimea.

Two years later Sergei, living in Kiev and tormented by black envy of those who were leaving for the glider rally in Koktebel, would remember those trips and say: 'If only I had the *Mayana* now.'

Strangely enough, the yacht has outlived its young sailor, and is still afloat.

Not only the yachts in the port came back to life. The gay noisy giant who blew life into Odessa, the darling of Russian cities, the town everyone loved, seemed to be waking up. The customs weighing-bridge at the harbour gates began ringing; the cranes on Platonov Pier began puffing and became shrouded in billowing clouds of steam; and the white caps of the dockers flashed and gleamed more and more often. Sergei was no stranger in the port, and he, too, already knew the whole motley crew: Mishka Elephant, Vaska Machine-gun, Misha Camel, and the Savage—the dockers were always known by nicknames; surnames were seldom used. They didn't have much work to do yet, but the first ships of Export Lines had already arrived and the bright, long-forgotten paint of the first, brand-new Fordsons, seeders, winnowers, harrows, and mowers was glittering in the grey Odessa docks, and cattle, grain, and pulses were being loaded into the empty holds. And in this lively, quick kaleidoscope of sounds and smells there was an island that always drew Sergei, Khlebnaya (Grain) Haven.

This spot was quite far from Platonov Pier, but it was there that Sergei dragged his friends to swim and sunbathe. There they dived, and raced, and splashed in the foam, and tried to out-do each other holding their breath under water, and sat drying on the warm black iron of a half-submerged dredger, shivering and blue with cold, with their knees drawn up to their chests and their lean bellies drawn in. Kalashnikov and Kotka Berens would start loud arguments about gymnastics, about training for the next Falcon Competitions. Yoffik and Tolik Zagorovsky would sneer at Timtsunik's moralizing, and ridicule Alexandrov, and condemn Bortnevsky's latest hang-over with all the cruelty of youth, and make condescending remarks about girls. This little iron island was boys' salon. Sergei Korolev was a poor con-

versationalist and rarely joined in their arguments—not because he didn't care a fig for the affairs of the Falcon Club. He, too, trained there, in gymnastics and boxing. And he didn't get on too well with Timtsunik. And he wasn't indifferent to girls, at least to one. It was simply that his interests lay elsewhere: in Grain Haven, behind a barbed-wire fence near the Weinstein mill, was the base of HYDRO-3, the Third Sea-plane Squadron of the Black Sea Fleet.

This wasn't the first time he had noticed the flying boats. He had been watching them for a long time, since they first arrived in 1921. And he often wondered how these noisy frail-looking machines worked. They were nothing like the kites he used to fly from the pier. What a lot of kites he had made! It had seemed to him then that he could make a kite big enough to carry a man. Once he even asked his mother for two new sheets: he wanted to tie them to his arms and legs and jump from a high brick chimney. He would have crashed for sure. A kite's all rot. Here you have an engine, and an air-screw.

HYDRO-3 drew Sergei Korolev more and more strongly like a magnet. Its name covered eight planes—six operational and two reserve—eight utterly worn out, repeatedly patched up, little plywood M-9 biplanes, designed by D. P. Grigorovich.

This hydroplane, first tested in Baku in 1916, had been very successful in its time. It was noted for its reliability in the air, and by good seaworthiness; it could cope with waves half a metre high, was easy to fly, and was a good all-purpose machine. The M-9 could be employed, if need be, as a reconnaissance and patrol plane or as a bomber. The old Odessa Nines had a heroic story: they had flown against Wrangel, and fought on the Dnieper. Their commander Alexander Shlyapnikov had even stormed the Winter Palace. The Nines were heroic, there was no denying that; but they were old, very old.

But Sergei didn't know that. To him the hydroplanes

were a wonder, a fabulous hybrid born of two boundless elements, the sea and the sky. How often, sitting on the rusty side of the dredger, he would follow with unswerving gaze, how slowly and carefully a hydroplane was rolled out of the hangar with a kind of gentle animation on its trolley, and how sun-burnt lads in sailors' vests took hold of its sides and carried it along a wooden jetty to the sea and carefully and gently put it down on water. And then the flying boat would start to rock and sway, and move as if impatient to get over there quickly, beyond the breakwater, where its road to the sky began. The floats on the wing-tips would become submerged for a second, but immediately pop up again, washed and shining. From above the hydroplanes were bluey-green, the colour of sea-water, and from below bright yellow, so that even on cloudy days sunny specks reflected from their wings twinkled on the water.

The Nines raced across the sea faster than the *Mayana*, and yet they could fly, as well! Over there, beyond the breakwater, they could see not only the Odessa Steps, the bronze Duke, and the windows of the London Hotel, glittering behind the green trees of the boulevard, but everything behind the steps, everything behind the Duke's back, and the cramped courtyards of the London—the whole town! To fly in a hydroplane became a mania, an obsession, with Sergei. He saw no way to make his dream come true. He just went to the Grain Haven, and sat, and watched and waited for a chance to get through the forbidding barbed-wire fence. Sometimes he swam close to jetty and tried timidly and awkwardly to start up a conversation with the lucky beggars who lived behind the wire. More often than not he was shooed away by the sentry; then he went and sat again on the dredger in anguish and resentment against the whole world.

But gradually they got used to him, or, perhaps sensed his passionate curiosity.

Imperceptibly, a kind of indefinable situation came about, that had no really defined beginning and was best described by 'he wormed himself into their confidence'. And the day came when he stood on the promised land of the squadron's base.

In fact, there was a circumstance of no little importance that, on one hand, had reinforced young Korolev's interest and, on the other hand, had made the job of penetrating the defences of HYDRO-3 easier. It was an event of national or, if you like, even of international importance. Those were the days when the Society of Friends of the Air Force (SFAF) was inaugurated. 'Give us wings!' was the slogan of the year in 1923. In 12 months membership of the Society rose from 16 000 to 1 022 000. Branches of the SFAF sprang up everywhere, even in Soviet embassies abroad. Air clubs, flying courses, flying circles, aero-exhibitions, and so on, sprang up like mushrooms. There was no town where funds were not collected to build planes and gliders; and nearly every town built them. Rabcors* paid a percentage of their fees to build a plane to be named 'Rabcor'. The Union of Chemical Workers collected for a dirigible 'Red Chemist-Rubber Worker'. In the villages frightened peasants were taken up for rides in air-propaganda planes. Special display stands toured the country fairs. Air plays were staged at clubs. Air libraries were set up. It was planned to raise the membership of SFAF to three million by 1925. The importance attached to the new society can be judged by the election to its Council of such Party leaders as Bubnov, Eiche, Frunze, Kalinin, Mikoyan, Ordzhonikidze, Podvoysky, Stalin, Voroshilov, and Yakir.

In some places undoubtedly the campaign, so to say, overreached itself, became a show, and reports for reports'

* Rabcor, workers' correspondent, part-time newspaper reporter working in a factory.

sake, and fantastic projects for planes 'driven by electrified sand' (Andrei Platonov satirized it in his *Gradov City*). In short, there was everything that comes from the combination of excessive administrative zeal and crude superinitiative.

Sergei Ilyushin, already a prominent airman and designer, wrote bitterly that aviation circles 'sprang up like mushrooms, and were numbered by the hundreds by the end of 1924, but just as quickly disintegrated'. But all the minuses could not outweigh the pluses.

The pluses were incomparably greater. The passion for flying was not simply youthful enthusiasm. It originated from the admirable conviction that a free people must and can overcome immemorial and humiliating backwardness in every field, and do it quickly. And this feeling was reinforced by a clear understanding of the need to strengthen the defences of the young republic. On posters were blazoned: 'Let us answer the imperialists' mad development of armaments by new squadrons, built by the workers and peasants of the Soviet Union, friends of the Air Force!' This was not very fine, perhaps, stylistically, but quite to the point.

Many years later, another aircraft constructor, Oleg Antonov, who took his first steps in aviation in the SFAF, wrote of these years with as much justification as Ilyushin: 'Where did these quite young lads, members of the Young Communist League, schoolboys, even Young Pioneers, get such confidence in their own strength? It stemmed from the very spirit of the times. Everything around them was being rebuilt: new social relations, industry, agriculture, science, art. It must have been the example of our elders, who were courageously tackling these unprecedental world-historical problems, and the flourishing of popular talents eagerly starting peaceful creative work after the terribly arduous years of civil war and intervention that encouraged us by creating an atmosphere of general self-confidence... .

'The founding of the Society of the Friends of the Air Force in 1923 was an event of major importance in the life of the Soviet land. It opened the sky to youth crazy about aviation.'

The work of the SFAF was noted in the resolution adopted by the XIII Party Congress when a squadron bearing the name of Lenin was formally presented to it.

There will be more occasions when the attentive reader will find himself wondering at the lucky coincidence of Korolev's aspirations with the summons of the time. Karl Marx might very well have had Korolev in mind when he wrote it was still not sufficient for thought to aspire to fulfilment in reality, but reality itself must aspire to thought.

The fate of every great cause is made up, like a jig-saw picture, of the fates of many people. Of course, shivering, young Sergei Korolev, swimming close to the jetties of HYDRO-3 did not connect his desire to climb onto the jetty with the future of aviation and of rocket technology. But we, today, can see this connection through the prizm of time.

A branch of the Society of Friends of the Air Force was set up in Odessa, too. It was impossible for the city, whose idol had been Utochkin, that had built planes back in 1909, and had had an aeroplane factory from 1913, to remain aloof. The Odessa Branch bought an old Khioni-5, a plane called after its instructor Vasily Khioni, and turned it into a flying agitator the 'Little Humpbacked Horse'. Publicity flights were made over the town and neighbouring villages; and dare devils were taken up from the Rifle Ranges. The pilots of HYDRO-3 spoke at endless meetings, get-togethers, and conferences, lectures, gave lessons, 'liquidated aviation illiteracy', scattered leaflets over the town, saying: 'Working men, build your own air force!' And although the squadron was a military unit, and therefore strictly observing military regulations, it could not dissociate itself from the slogan 'Give us wings', not even ter-

ritorially; and it took all its commander's will-power not to notice the outsiders who got into the base.

There were a lot of them. Sergei Korolev was by no means alone. There were idle onlookers, the frankly inquisitive, and the earnestly interested. There was even a poet—a fat fellow who was eternally muttering something under his breath and who had sworn to praise the squadron in verse. Keen students from the Polytechnical Institute were working there, too. Sergei was too young, even for those years when youth was not a handicap, and too inexperienced for any serious job in the hydroplane squadron to be entrusted to him at first. But soon everybody noticed the boy's amazing persistence in anything connected with his initiation into aviation. There were few people in the squadron—eight pilots and four mechanics in all—and no lack of trouble with the old Nines. There was plenty to do for hands honestly willing to help, however inexperienced. The pilots Konstantin Borovikov and Alexander Alatyrtsev, and the mechanic Vasily Dolganov took more notice of Sergei than the others did. They had common ground: Borovikov had a passion for yachts, Alatyrtsev boxed, and Dolganov simply liked inquisitive people.

'Now look here,' the mechanic would explain unhurriedly and with enthusiasm, 'this is the engine, a Salmson, one hundred and fifty horsepower, and nine cylinders, radial. And these are the radiators: one here and a second there. This is the carburettor, as you can see. That is the oil-tank. Now, here's a question. How does the oil flow? Well, look... .'

Pretty soon Sergei had learnt from Dolganov not only the principles of the design of the flying boat, but also many fine points about its construction and the way the engine worked. Soon even the stripping of the engine, which he had previously regarded as a holy ritual, lost its mystery for him. The veneration of ignorance gave way to the interest of knowledge. He could now distinguish the flying boats

not only by the ace of spades or ace of diamonds, the personal emblems painted on the fuselages of their Nines by the pilots, but by the way they took off, the way they turned, and the way they landed. He had climbed into the pilot's seat more than once, and pressed the pedals and moved the joy-stick and occasionally the thought came to him, which would have seemed heretical yesterday: was it really so difficult to fly? And the day when Shlyapnikov took him up on his first flight Sergei remembered all his life.

They flew out beyond the breakwater, climbing against the wind, the engine roaring, and fine, flattened ripple of the sea began to dance in their eyes. At last they raced ahead, and suddenly the port, the buildings, the trees, everything began to fall away somewhere, and Odessa moved and slowly began to swim. Sergei saw tiny people, toy ships, soon his eyes found Platonov Pier and his home: 'What if they saw me now! Perhaps, it's just as well they can't.'

He didn't talk about his flight at home; he didn't want to frighten his mother, and was afraid of his stepfather, knowing that the latter did not approve of his infatuation with hydroplanes. They probably would not have found out, if he had not himself been indiscreet.

One day he was walking with his mother along Pushkinskaya Street, towards sea. It was a wonderful blue sky. The pavements were speckled with the bright sunlight that penetrated the branches of the old plane trees and looked like expensive carpets.

'What a beautiful day it is! Look, what clouds, almost silver,' she said.

'If you only knew how they look from above!' Sergei suddenly blurted out. 'They're not silver, but pink up there, they billow and glisten and shine.'

His mother stopped:

'Have you seen them?'

'Yes, I have,' Sergei hung his head. 'I flew in a seaplane. You see, I was afraid you'd forbid it and talk me out of

it, and cry.—There's nothing really to be afraid of! Wait till I learn to fly, and take you for a ride. You'll love it, I'm sure.' Sergei fell silent and then added quietly: 'Don't tell Greg,' as he called his stepfather.

He didn't get on very well with his stepfather. Balanin was not an unkindly man, but rather reserved; being a kind man himself he knew better, from bitter experience, than to trust too much in the kindness of others; and this made him strict with Sergei. He willingly and clearly explained difficult places in mathematics, mechanics and strength of materials, but heart-to-heart talks on simple everyday matters seldom took place between them. Balanin loved Sergei in his own way with captious, jealous love. In the days of famine he had given him his last crust of bread, his last grain of sugar, and sometimes would be tender in his actions but always stern in his speech. Sergei didn't like the big flat on Platonov Pier and noticed that his friends, too, did not like visiting him. Balanin somehow paralysed them. He would come in, hardly ever speak, and never made any comment, but their conversation would dry up immediately. They, too, would become silent and hurriedly begin putting their things on and go home. With his mother it was quite different. Everybody loved her. She was gay, one of them. With her they could play, and romp, and joke. He didn't realize then that his mother was still under 35.

The sports club, the yachts, the squadron—of course, all told on his studies. As soon as he would get home from school he would toss his note-books aside and hurry off to the Grain Haven. Sometimes he got a pass and sometimes a bad mark. And then Temtsunik poured oil on the flames.

Temtsunik, the mathematics teacher and Sergei's form master, came to Platonov Pier and in a short chat with Balanin, leisurely brushing his thick Bessarabian moustaches, he gave him to understand quite unambiguously that

Sergei's progress left much to be desired and that he hoped a serious talk at home would do Sergei good.

Balanin's frown became blacker and blacker.

'There's only one thing I want,' he said. 'I want you to become an educated man with a profession. Education and a profession will make you independent, and that means strong and bold. In any field the person who is unqualified is dependent, not free. Remember that. Handstands, yachts, aeroplanes are all rubbish, the easy way, not caring. I won't let you become an idler or an ignoramus. I won't allow it, do you hear?'

Sergei hung his head. His stepfather was partly right. Of course, he must study. But planes, surely they were not rubbish.

'Then why did you join OAVUK if aeroplanes are rubbish?' he asked scowling.

'I consider that it is a necessary and useful job. The country needs aeroplanes and I'am ready to help build them. But I've my own job and my own head on my shoulders. But you, you lack both just now. And I'm afraid you'll never have them! Yes, that's what I say, you'll never have them! That for you and your OAVUK!'

In the first years of the Revolution (obviously, in the desire to shed the old ways) people in Russia became very fond of every imaginable kind of abbreviation, often quite strange sounding. For instance, there was a theatre in Odessa 'Massodram', that is to say Workshop for Socialist Drama. OAVUK, the mysterious subject of Sergei's row with his stepfather, could be deciphered as the Society for Aviation and Ballooning of the Ukraine and the Crimea. In March 1923 a Society for Proletarian Aviation had been founded in Odessa, but soon re-named OAVUK, and became the republican branch of the SFAF. The representative of the Narkomindel (the People's Commissariat of Foreign Affairs), Kozyura, a man passionately fond of flying, became its chairman. But, because of his multifarious duties and

responsibilities, actual administration was in the hands of the former director of the airport, Faierstein. The members of the committee included Shlyapnikov from HYDRO-3, and Lavrov, the commander of the fighter squadron, Shlyapnikov's land-based counterpart.

Sergei and his friends Kalashnikov, Sirotenko, and Schultzman, having somehow passed all their exams and wheedled fifty kopecks each from their parents for the entrance fee, went to 29 Pushkinskaya Street, to the splendid villa of A. A. Anatra, the former banker and owner of the Odessa aeroplane factory. It was the headquarters of the Odessa branch of OAVUK. There they were met by Faierstein, a puny little man with thick hair that he wore brushed on end. Being young (though Sergei Korolev considered 26 quite a respectable age then), Faierstein was exceptionally vigorous, quick, and light-footed. He could do a dozen jobs at once, cursing, praising, asking questions, controlling everything. He was always flying off on missions of all kinds organizing the preparations for the first All-Union Glider Rally planned for autumn in Koktebel. He fired a hail of questions at Korolev and his mates, and from their muddled answers understood that they were quite green kids, but ready to work with a will. He advised them to get right down to the theory, and fired a broadside of a dozen book-titles at them and disappeared.

Sergei Korolev spent the summer of 1923 under the 'sign of the propeller'. Despite his stepfather's dire warnings he not only refused to leave the hydroplane squadron at Grain Haven but even persuaded his friends to come there with him.

'Come on,' he urged Vladimir Bauer. 'There you are still lying in bed, and I'm already flying over Odessa. Well?'

Sergei flew quite often now. He was always by the side of Borovikov as a mechanic, and often went up with him on training flights, and not only with him. There was the pilot

Brzhezovsky. Once his engine cut out; Korolev climbed out on the wing of the biplane, reached the engine and was just managing to check the oil supply when the plane shook violently and Sergei fell off into the sea. Luckily, Brzhezovsky was already making a forced landing, and the water was only ten metres or so below. Sergei surfaced frightened and happy. Brzhezovsky landed and took him on board. They finally reached the shore after more adventures, like straying into a minefield. Sergei became a hero, but Brzhezovsky was cursed by the pilots, although he was quite blameless.

After flights they sometimes walked to the *Gambrinus* in Deribasovskaya St. The modern pub with this famous name is not exactly on the spot where the old *Gambrinus*, made famous by the gypsy musician Yashka and Kuprin, used to stand. The old place was in a cellar at the corner of Deribasovskaya and Preobrazhenskaya Streets. It was always noisy there, but brawls were rare. Sergei wasn't given vodka, but was treated to dark beer. He was glad, as he was afraid to drink vodka. All his life he was not exactly a teetotaler, but a man quite indifferent to alcohol, although there were many occasions to 'drown his sorrows in wine' or raise his glass high toasting a triumph.

Though exulted by his aerial adventures Sergei did not, however, forget the advice of the energetic Faierstein. He found some of the books recommended in the OAVUK rooms on Pushkinskaya St. and some in the public library. He was well known there: he had often worked in the reading room in the winter with Valerian Bozhko. He leafed through the books eagerly and haphazardly. There was much he couldn't understand. He asked his stepfather, and the latter explained it if he himself could sort it out. Balanin was an expert in cranes and electrical engineering, and that had little connection with aviation. He was able to help Sergei more in another sphere: OAVUK had received some books from Germany, and Balanin could read German fluently.

Sergei read through a mass of books on aeroplanes and bird-like machines, and treatises on the first aerodynamic wind tunnels, and manuals on aircraft engineering.

The Germans wrote in detail, circumstantially and boringly, but were still more or less understandable. The specialist books on aircraft construction and on stabilization and calculations of stresses proved more difficult. That was when his knowledge of building mechanics and the strength of materials, though very elementary, proved useful.

It may be that then, in the public library, the April 1918 issue of the magazine *The Past* which was available at the library came his way. The magazine reported at length on an idea by Nikolai Kibalchich, and in a postscript Prof. N. A. Rynin wrote: 'Kibalchich unquestionably has priority in the idea of using rocket motors in aeronautics.' If Korolev did, indeed, see the article, then the ingenious simplicity of Kibalchich's vision, which transformed the dream of interplanetary flights into engineering reality, could not have failed to excite him.

On Cathedral Square Lyalya was giggling at George Nazarkovsky's silly jokes. Kalashnikov was making giant swings in the horizontal bar at the Falcon sports club, Vladimir Bauer was probably taking his red dog for a walk. And a white ship steamed from behind the Venetian blind on the balcony, its necklaces of portholes gleaming in the dark. Somewhere, far away, a brass band signed faintly. But Sergei went on reading about Heisler's propeller. Perhaps on such a dreary evening there was an unbelievable mix-up: the neat diagrams and drawings in the German books dissolved into bright posters decorating every lamp-post in Odessa: 'Expand Aviation by Chemistry!', 'Give Us the Engine!', 'Master Flying!' And then, perhaps, he suddenly thought he could build a plane himself and take it up into the sky himself! Himself! Well, perhaps not a plane, maybe just a glider. But it would be HIS glider!

The very idea that it was possible took his breath away.

Soon it began to rain, stormy weather set in, and the hydroplanes in Grain Haven were not put out from their hangars. Summer was over.

CHAPTER 7

Classes recommenced at the Building Vocational School. It was the final year, and Sergei decided to do his best. The German teacher Gottlieb Ave was astonished to discover that Korolev was becoming his best pupil: he knew nothing about the books by German aviators. And Stilianudi was satisfied: Korolev did his drawings quite professionally: the shading was not rubbed out, and all the arrows were neat and not skew-whiff.

In Vavizel's workshop they were now trying their hand at making rafters, were mastering mortises and joints but, of course, there were also simpler jobs such as making axe-handles, rakes, window boards. One day Lyalya Vincentini announced that she and her brother had enrolled in the 'Training courses for the technical staff of administrative, public, and commercial offices'. It was impossible for Sergei not to enrol too. They took a course in shorthand and were taught the Terné system. The young people took to this like ducks to water, outdid one another in speed, and threatened to break the record of the Odessa stenographers who had managed to take down a speech in the City Council at a rate of over two hundred words a minute. But for all that the administration criticized Alexandrov for isolation and grammar-school academicism, so now the final-year students, or probationers, as they were called, spent more time on special building subjects.

Korolev worked with Bozhko. Sometimes Kalashnikov joined them. Together they built three-dimensional geometrical figures and hung them on threads so as to make projections on various planes and to develop their spatial imagination. The more Sergei watched Kalashnikov, the clear-

er it became to him that here, underneath the jauntiness, repartee, and bravado of the 'typical Odessa boy' was an earnest clever lad. Kalashnikov's father was a famous local second-hand bookseller, their flat was stuffed from top to bottom with rare books, and the son was probably the most well-read lad in the class. He had an excellent knowledge of Odessa's history, and literally knew the story of each one of its houses; but he never took advantage, and when conversation turned to books would suddenly become unaccountably modest.

But neither Sergei's roomy flat on Platonov Pier nor Kalashnikov's book treasures had attracted them like the Vincentinis' unpretentious flat. To be more exact, this flat was remarkable for its cordial, gay, simple, and somehow exceptionally liberal atmosphere, to which all its occupants—young and old—contributed. The Vincentini brother and sister—Yuri and Xenia—were Sergei's classmates. Yuri was tall and awkward, while Lyalya (as she was called) was slender, very pretty, with a plait that hung below her waist and big eyes. It was rumoured that their ancestors were immigrants from Italy, who had come ages ago to the south of Russia to grow grapes. With the exception of their surname it was difficult to see anything Italian in their parents, although the father, a railway engineer, was very musical and loved singing as much as a Neapolitan. But it was not the songs and music; the important thing about him was that he was simply Max to Yuri and Lyalya and all their friends. This jolly, clever man was one of those lucky people who always, right through all the years of their children's childhood, adolescence, and maturity, remain their friends. His wife, Sophia, was a woman of generous spirit and sincerely fond of all the boys and girls who were constantly running in and out of her home. Half the class must have gone to the Vincentinis'. It was not only a place for studying, for arranging various ingenious self-tests before exams, but a place to get warm on cold

days, and to get a bite when you were hungry, and that was quite often in those years, and there was seldom anyone too proud to refuse plain tea and potato fritters. And they enjoyed themselves there. There all their future street pranks were born; there they sang, and danced, and acted comic scenes of all kinds, and played charades. It was a place to go for a walk from and return to. Nobody could ever remember Mrs. Vincentini reproaching him for dirtying the floor. In fact, the Vincentinis' was a young people's club, that rare club where it's always jolly and interesting. If something happened, the Vincentinis were the first to know, for people rushed there first. Suppose the school wall-newspaper was taken down because of digs at the teachers that were considered disrespectful. There would be a meeting at the Vincentinis'. Once, when one of the teachers was late for his lesson, the entire class walked out and went to Shevchenko Park. And of course it had to be the very day one of the frequent inspectors arrived to check on Alexandrov.

'Make things hard for me, I'll put up with it,' the agitated director of studies said the following day. 'Make it dangerous for me, and I'll put up with that, too. But don't make a fool of me!'

Afterward, they met in silence at the Vincentinis'.

'It goes without saying,' quietly sighed Bozhko, 'as Y.C.L. secretary, I think we behaved like swine.'

That evening Max and Yuri did not touch the piano.

That autumn Sergei Korolev went to the Vincentinis' almost every day. As usual for him, he never pushed himself to the centre of the company but usually occupied a corner somewhere and sat still with only his black eyes shining. He understood that this home could get along quite well without him, but he could not do without it: he was in love with Lyalya Vincentini.

If lovers can be classified, he belonged to the type that are hopeless admirers, whose fate is usually a sorry one,

for there are always active, energetic rivals to whom the silent admirer gives way. He knew only too well what a brilliant witty rival was! He had two of them! And what rivals! George Kalashnikov and George Nazarkovsky. The former was a brilliant gymnast, and swimmer, and wit, and erudite; the latter was the acknowledged idol of the drama circle, the favourite of the literature teacher Zlatoustov who gave him the most difficult parts in Ostrovsky's plays, a handsome lad—many a girl had her heart set on him—and he knew it. What could he, Sergei Korolev, put against Kalashnikov's cascades of wisecracks or Nazarkovsky's lyrical roulades? A talk about the construction of the Miller and Rumpler aeroengines? Or a discourse on the physics of aeronautics? So he sat in his corner, silent, only his black eyes shining.

Naive like all lovers, he thought he was hiding his feelings toward Lyalya so cleverly and successfully that nobody suspected them. It was only when he heard Olimpiada Melikova, the leader of their class, recite epigrams about the lads at the school New Year party, that he realized that everybody knew his 'secret'. The epigram went on like this:

Now take Sergei Korolev
Any minute he'll take off,
Like a human parachute,
Like a pilot will he shoot!

And like a swallow dive
Right over the teacher's desk.
It's my wish to see him rather
His audacious pinions fix,
And fly swifter to the house
With the numbers six and six!

Six and six! Novoselskaya St., 66—that was Lyalya's address! Red as a lobster he dashed out into the corridor. And walked up and down abashed, happy, unhappy.

Melikova's ingenuous verse gave quite an exact picture of Sergei Korolev at the beginning of 1924. He was, indeed, ready to do a swallow-dive every minute. Most of the boys

at the Building School were mad about sport—sailing, swimming, boxing, football, weight-lifting, but mainly gymnastics. There were several sports clubs in Odessa then, the Alasko, the Turn Verein and the Makabee. Korolev and his friends went to the Falcon Club; Kristalev, the gymnastics instructor at the school, was also the coach there. The club was located in one of the buildings of the New Market, and for a small fee provided members with the facilities of a well-equipped sports hall. Kalashnikov, Berens, Zagorovsky, Korolev, Egorov, and other lads from their class attended twice a week. And Korolev and Bozhko also took boxing lessons. Bozhko managed to train his only hand so well that a single left could knock a brawny fellow down, and toughs of Odessa had great respect for this one-handed boxer.

Falcon members were divided into squads according to their proficiency in sport. The first, second, and third squads were distant analogues of the present-day Soviet sports classification with its first, second, and third category ranking. To begin with Korolev was in the third squad, but was later promoted to the second. Only Kalashnikov and Berens were good enough for the first, and they were extremely proud of the fact. Although Korolev spent less time on gymnastics than the others he had a reputation at school as a fair athlete. This being mainly due to his vaulting over the teacher's desk during breaks mentioned in the verses, and his walking on his hands. Young Korolev was very fond of handstands and walking on his hands. At home on Platonov Pier he and Kalashnikov gave themselves thrills by standing on their hands on the balcony railings. Sergei even went so far as to make special supports for his hands and could walk for quite a long time with his legs in the air. Once he walked on his hands the whole length of the school corridor and would have gone further if his friends, seeing his blood-red face, hadn't been afraid he would have a haemorrhage. Sergei was very proud of this trick. Years

later, when conversation turned to the training system for spacemen and their physical training, he would often smile and say:

'You'd never guess how I could walk on my hands.'

The line in the verses fixing his wings recorded his passion for aviation. Though unsociable and normally not eager to share his plans, thoughts, and dreams even with his closest friends (which incidentally makes his biographers' task very difficult) young Korolev made no secret of his fondness of flying, but advertised them everywhere trying to draw as many people as possible into the world of his happy hobby. He was a clever agitator, never exhorting, never trying to force anyone against his will. He would begin with an abstract air to describe all the delights of a flight, to draw pictures of the earth from high up never seen by his listeners, and paint fantasies of the extraordinary radiant future he thought awaited flying. He took his time, setting his listeners alight from different sides, and waiting for them to catch fire. And they did catch fire! Nearly all the lads of his class were members of OAVUK, especially since the school was in favour of their taking an interest in new technology.

That autumn Sergei began giving talks and lectures to liquidate 'air-illiteracy' in various big factories, in the port, and at the Odessa naval base, where HYDRO-3 was stationed. Faierstein was kept busy writing out vouchers for him. Sergei himself liked giving lectures there, and it was a way to earn a little money, not much, but something. He was tired of asking his mother for twenty-kopecks pieces. He wasn't a boy any longer and needed pocket money.

A note by the leader of one of these OAVUK groups has been preserved:

> 'I suggest you to remunerate instructor Comrade Korolev for the lectures he gave in my group twice a week in the period from 12.VI to 15.VII of this year. Total 8 (eight) lectures.'

Once, when he was lecturing to the port workers, he noticed his stepfather among the audience. Balanin's reproaches were now much rarer; he felt that aviation was not just a boy's fancy, but a real passion.

Sergei took his work in these circles very seriously. The minutes of a session of the Odessa Sport Section record his report as follows:

> 'The circle organizer Com. Korolev informed the Provincial Sport Section of the numerical and qualitative membership of the circle, pointing out the low level of knowledge about aviation and the strong desire of the members to work. The circle proposes to build a glider of its own design. Lecturers in theory are needed.'

It was a rare day now that Sergei failed to visit OAVUK House on Pushkinskaya St. Everybody there knew him now, and he knew everybody. Things were buzzing at OAVUK: an 'Air Week' was being prepared, and work in the sections being organized. The constructor's section was headed by an experienced flyer, Vasily Lavrov, the commander of ISTRO-2 (i.e. the 2nd Fighter Squadron), the glider section by Leonid Kurisis, a student at the Polytechnical Institute who had gone that autumn to the First All-Union Glider Rally in Koktebel. Korolev had already gone to the meetings of the glider circle during the last summer, and as he began reading he realized that it was not so simple to build a glider, that the main thing was not to get good lathes, thin plywood, and strong percale, but to be sure of the design before beginning to build it. At the circle, although to all intents rigorous calculations were made, much was done by the rule of thumb; they were so eager for immediate activity that they reconciled themselves to theoretical ignorance with light-hearted empiricism.

Again and again Sergei became convinced that the keenest enthusiasm, the most sincere desire to do the job were not

enough, that without knowledge the job was more likely to be botched, made stupid and ridiculous, and discredited.

Faierstein published an article in the local *News* with the resounding slogan 'We Need Projects, Many Projects! Everyone down to Work!' Crowds of home-grown designers and constructors, with rolls of drawing paper under their arms, poured into the house on Pushkinskaya St. Some not only knew nothing of aerodynamics but stumbled in arithmetic. How Sergei would wish he didn't need wait another day to start building his (own) glider! But he reined himself in, seeing Faierstein smile as he unrolled a drawing of yet another aero-revelation. No, it was too early to begin. Korolev went to all the sessions of the constructors' section, and diligently took down Lavrov's lectures in shorthand. In this seventeen-year-old youth could already be seen traces of the strict rules that the great constructor was to observe all his life: no experimenting in the dark, no reliance on experience, flair, and intuition. Every solution of a problem must be solidly grounded—a sheet of paper with figures is the seed of a future machine! At the same time, down with paper machines! An idea, however beautiful, is dead until it is embodied in hardware. Words, however precise, are only time-consuming reverberations in the air if they are not backed up by supporting facts.

Sergei Korolev began working on his glider, his first independent constructor's job, in the winter of 1923-4. Now he went less and less often to the New Market and the Falcon Club, and even at Lyalya's he became a rare guest. The general excitement at OAVUK spurred him on, but he held himself back from hurrying. Once answering a query from Kurisis as to when he thought he would finish his project, Sergei said: 'I don't want my glider to be the first. I want it to be the best.'

The first conference of Odessa glider fans opened at twelve o'clock on April 13, 1924. Korolev sat listening to Faierstein's report: he talked about the first developments in

gliding in the Ukraine. Exactly thirteen years later, to the very day, Korolev listened to a lecture 'Interplanetary flights' in the Big Hall of the Polytechnical Museum in Moscow by Prof. V. P. Vetchinkin who talked about the speeds required in order to leave the Earth, presented calculations on the mass of propellant needed, and drew diagrams of rockets and motors. Exactly thirty-seven years later, to the day and the hour, Korolev listened to Gagarin's account, telling about man's first flight into outer space.

Our story is acquiring many aspects: school, Lyalya, the Falcon Club, OAVUK. In life it was not so. In life all the aspects were intermingled. Our neat scheme of preoccupations and enthusiasms was no system at all, but a motley, lively hodge-podge. Yet its intricate, unpredictable motion obeyed his will in some way. Already in those years his character had begun to show signs of a very rare, fanatical, all-conquering stubbornness, an ability to overcome and, if need be, to break down all obstacles in his way, to suppress and hold back all distracting impulses and not give them free rein, consciously to embrace a spiritual ascetism, sacrificing everything to a set goal, that is to say, all the qualities that were so essential to him in the future.

His main goal then was the glider and a future job in aviation. He had already decided that he was going to build aeroplanes and fly them. There was no wavering on that subject. The Vocational School was making him a builder. He was grateful to it for the mathematics, the physics, and the strength of materials, but he was not going to be a builder. That was settled. That made it all the more distressing that he now had to divert his attention to the final examinations, to waste hours on textbooks that could be spent building the glider.

The New Year, which was ushered so gaily on Staropor-

tofrankovskaya St., began badly. In January came the sad news from Moscow: Lenin was dead. That was unexpected. It was known he was seriously ill, but in recent months Sergei had often heard 'He's better', 'He went for a walk', 'He's reading'. Everyone hoped Lenin was convalescing. It seemed only a short time since they had sent him a letter in Gorki:

> 'The first city conference of the Odessa Provincial Branch of the Aviation and Aeronautical Society of the Ukraine and the Crimea sends greetings to the Leader of the World Revolution, to dear Ilyich, and wishes him a speedy recovery. The workers of Odessa are making every effort now to build a powerful squadron to be named in your honour in the hope of seeing you at the controls of the Leading Plane of the World Red Air Fleet.'

And now he was no more. 'Who was going to take over the controls of the revolution now?' everyone was wondering.

Toward spring all sorts of unpleasantnesses struck the School. The permanently boozy director Bortnevsky was finally sacked although, in fact, having delegated all his powers to Alexandrov, he bothered nobody. The new director, unlike the old one, who had been a slave of Bacchus, turned out to be a devotee of Venus and was soon shot by someone mad in the jealousy. There was no end to the rumours, scandal, and gossiping. It was all disruptive of normal school life, especially just before finals. But Alexandrov was not prepared to give up. He believed in his lads and did not abandon his educational experiments.

'Why should we turn our examinations into a kind of sacrament?' he said. 'The table covered with green cloth, the examiners sitting there like judges, the pupils trembling. Why? The atmosphere should be such that a person doesn't have to worry, will feel unfettered and free.'

That was how the idea of the Alexandrov tea-party was born.

On the day of the last physics exam the walls of one of the classrooms were covered with rugs brought from home. And there was a couch (also brought from home) on which the examiners sat—Alexandrov, Tverdy, and Temtsunik. In front of them was a table covered with a tablecloth, an enormous five-gallon samovar, a dish of pastries, and sugar. Lydia Gombkovskaya fussed about the table, pouring tea, offering cakes.

As Sergei entered he was first astonished, then angered. He had been against the tea-party idea and now the whole thing seemed to him even more forced and false. Rattling the spoon, he pushed away the glass of tea filled by the excitedly flattering Lydia. 'By the way,' said Alexandrov in a soft, even slightly relaxed voice, 'won't you tell us why the spoon in the glass appears to be broken in two?'

Sergei answered.

'Suppose this carpet was illuminated by red light,' the question came from Tverdy, 'how would that change the colour of its pattern?'

Sergei scowled at the carpet, thought, and answered. Lydia pushed a plate with a pastry closer to him. Sergei unconsciously took a bite. 'Cherry tart. Tastes nice, damn it! But still it all looks stupid—a healthy lad sitting at his exams eating pastries.'

'Have you ever happened to take a walk on the sea-shore on a moonlit evening?' asked Alexandrov smiling.

'That really is too much! What's he hinting at? The house at "six and six" again?' Sergei blushed and forced himself with difficulty to say: 'Let us suppose it has happened.'

'In that case you could not have failed to notice the moonlit streak on the water, could you?'

'That's right, there is a streak.'

'Excellent! Now think, why is it that no matter where you go it always ends right at your feet?'

'So that's what it's all about. And I thought... .' Sergei

smiled and remained silent. Lydia hissed something at him, rattled the spoons, tried to prompt him, but he continued to smile at somebody, gazing right past the teachers.

'What are you smiling at?' asked Temtsunik with a puzzled air.

'Just so,' Sergei answered, and Lyalya's face disappeared.

Shortly before the exams Yuri Vincentini had gone down with scarlet fever, and Lyalya had moved to a friend of her father's on Naryshkinsky Hill. And so she became a neighbour of Kalashnikov's, who was known all over Odessa as George from Naryshkinsky Hill, but that gave him no advantage over his rivals Nazarkovsky and Korolev.

On balmy evenings the three of them went to see her together. Lyalya's room was on the ground floor. They could have rung the bell of course and gone in through the door like normal people, but they preferred the window. Boosting each other up they would climb up onto its wide white sill. How many evenings they spent sitting in this room in the deep dusk of the southern twilight, not bothering to put on a light, talking in subdued voices, silent for long spells! What did they talk about? It is difficult to remember, and even more difficult to put down in words on paper. They were in love. A witty Frenchman once said that lovers are never bored because they talk only about themselves. They weren't bored even though they did not talk about themselves. And what did it matter what they talked about? Sounds and silence, light and dusk, the wave of a hand and the turn of the head, the rustling of the leaves in the wind, the winking eyes of the stars—everything had its special meaning, everything spoke its own soundless language, knowledge of which suddenly comes to you out of the blue, and which you then forget, forget very quickly and forever.

They sat for hours—the three amorous boys—and made no secret of their intention to out-sit their rivals. Usually the first to give in was George Nazarkovsky.

'Lyalya! I can go in peace,' he would say from the window-sill. 'These chaps are my friends. I've asked them to protect you from all dangers, and I'm sure... .'

'Stop babbling!' Sergei would interrupt pushing him down. 'Those who are leaving should go away.'

Kalashnikov hung on tenaciously, there was hardly a person in Odessa who knew as many anecdotes and amusing stories. But he, too, would fall silent at last. A long pause would follow. 'Listen,' he would say, 'let's go together.' As noiselessly as cats, they would jump out of the window and run home.

But sometimes one of them would come back. And then he and Lyalya would stay in her room, or go down to the sea. And the moonlit lane, in strict compliance with the laws of physics, would run straight under their feet.

CHAPTER 8

As the inscription on King Solomon's ring said, everything passes. The last exams came to an end too.

> 'CERTIFICATE
>
> Issued to Com. Korolev S. that he was a probationer at the Building Vocational School in 1923-4 and passed the tests in the following subjects: 1) Elements of political knowledge; 2) Russian; 3) Mathematics; 4) Strength of materials; 5) Physics; 6) Labour hygiene; 7) History of culture; 8) Ukrainian; 9) German; 10) Drawing; 11) Manual training'

But he still didn't obtain his long-desired and much-needed freedom:

'To the Provincial Municipal Department

Building Vocational School No. 1 requests you to provide practical work for Com. S. Korolev, who has finished the course of theoretical studies.'

This practical work was intended as the final production examination of the future builders. At the time, however, it was not easy for even a qualified and experienced specialist to find work, and in the Provincial Municipal Department they racked their brains for a long time trying to think where to send these boys and girls. At last they thought of something: the newly graduated specialists were set to repairing the tiled roof of the Medical Institute under the direction of a tiler Efim Kvitchenko.

'To the Med. Inst.

In accordance with your No. 1972 of the 27th inst., we are sending a list of ten probationers to work at the Med. Inst.
Enclosure one.

List of Probationers

1) Kalashnikov, 2) Korolev, 3) Kreisberg, 4) Vincentini Yu., 5) Vincentini X., 6) Rozman, 7) Schultzman, 8) Borshchevskaya, 9) Marchenko, 10) Zagorovsky.'

To be honest, they worked badly, breaking expensive Marseilles tiles, doing things in a slip-shod way, in order to get sacked. They were not in a mood for work; what with the exams over, summer, the sea, the warm weather, and the time ahead, still foggy, but undoubtedly interesting. Like a flock of cheeky sparrows, they sat on the roof of the Medical Institute, realizing, however, that the flock was about to disperse, never to come together again, and

that this stupid tiling was the last thing that linked them together. These thoughts aroused that strange feeling when one was apt to cry and laugh at the same time. One moment they would fall serious, and Sergei would start telling about the Moscow aircraft designer Andrei Tupolev and his first wonderful machines, and next thing they would suddenly start larking about, Kalashnikov and Korolev taking the lead. They would run about the roof and stand on their hands on a cornice to the terror of passers-by. Lyalya's presence gave a special piquancy to everything and roused Sergei. Near her he would become worked-up, rash, and excited. And then he would suddenly calm down, withdraw into himself, and follow her with downcast eyes. Once larking about cramped dark attic of the Institute Lyalya's long plait fell unnoticed into a can of green paint. It was something horrible, that green plait. They wrapped it in newspaper, and Sergei carried it in Lyalya's wake, a small black-eyed page humbly following his queen. Lyalya often thought about the three boys who climbed in her window on Naryshkinsky Hill, trying to choose between them; but she couldn't. She liked each one in his own way, each had something about him—Nazarkovsky his careful artistic nature, Kalashnikov his quick, gay mind, and Korolev? What was there about Korolev? It was more difficult, you know, to define in one word. He had a quiet confident strength, you could see the constancy of his future character.

He carried her green plait as far as her house, and she thanked him with a smile in her eyes.

That summer, during his probation period, Sergei again started giving lectures and leading glider circles, again went to factories and to the port, and to his friends in the Grain Haven. Much had changed there during the winter. There were new people, strangers to Korolev, and new planes. Four brand-new Savoia 62s and a captured Austro-

Daimler had arrived to replace the worn-out Nieuport-21 and the old Nines.

'No more stinking Salmsons, Sergei. Do you know what engines they've got? Fiats! Ever heard of them? Three hundred horsepower!' Shlyapnikov's voice shook with unconcealed enthusiasm. 'Think of it. What power! Three hundred h.p.'

Sergei's eyes shone. It would be interesting to hear what Shlyapnikov would have said if he had known that this rosy-cheeked lad was going to harness a fabulous, mind-boggling herd of 20 million horses to his machine! Twenty million horsepower! At the time it couldn't even be called fantastic. But if people could see the future there would not be fantasy.

Old friends told Sergei how Rusakov had been killed in Sevastopol. He had miscalculated his landing and crashed into the hangar, killing himself and the mechanic. He had always been rash. Once he had bent a float in a big wave, and shouted: 'I'll repair it with my own money!' Shlyapnikov had calmed him down. Garusov, a reticent, intelligent man with the fine fingers of a pianist, had broken his leg on a training flight. It had been amputated and he had gone to Leningrad. Before leaving he had come to the Grain Haven, gazed at the hangar, then gripped his crutches so tight that his fingers turned white, and said quietly to nobody in particular, to the ground: 'It's the end. My life's over.'

Sometimes Konstantin Borovikov and Alexander Alatyrtsev took Sergei up with them, but not very often. No one had time to spare for him, for orders had come transferring them to Sevastopol, and there was a great deal of work to be done.

'Sasha, do take me up,' Sergei begged Alatyrtsev.

'Some other time,' the latter smiled. 'I give my pilot's word; next time we'll have a grand ride!'

It ended up on the dusty cobblestones of the tram ter-

minus in the Peresyp district with the plane crumpled as if someone had crushed it in his hand and thrown it down in the dust like a piece of waste paper. They carried Alatyrtsev into a chemist's shop. A bright thin stream of blood trickled from the corner of his mouth onto his chest. He was already dead, but still hot and sweating, as if alive. All Odessa went to his funeral.

After Alatyrtsev's death Sergei's mother had a talk with him (not for the first time) about his future.

'Don't you understand, this is a dangerous, terrible business. Garusov was lucky—he only lost a leg. Read the papers. I've been looking through your *Aeroplane*. Black borders in every issue. It's very dangerous, son, very dangerous.'

'But why do you think accidents only happen in the air?' said Sergei heatedly. 'Trains get derailed, and people get killed just falling off horses. But only pilots are written about in the papers, and horsemen never.'

'You want to be an engineer,' his mother continued. 'Fine. You're a capable boy and could make a good engineer. Go to the Polytechnic and study.'

'Greg is a good engineer,' interrupted Sergei. 'He's had prizes. His cranes are everywhere: here, and in Kamyshburun, in Mariupol, in Nikolaev, standing there like monuments. But I don't want to sit at the table over blueprints. And I shan't. It's not enough for me to go and look at the cranes they've made from my drawings. I want to test my own machines myself. I'm not going to go to the Polytechnic. They've got no course in aviation. I'm going to go to Zhukovsky's Academy.'

His mother began to cry. He came up to her, put his arms round her shoulders, and buried his nose in her hair, and said very softly but firmly: 'Don't stop me, please.'

'All right,' she said quietly, with her handkerchief to her lips. 'Go your own way. But I want you to do just one thing—consult your father.'

That summer Balanin was away on business. He had been called to Moscow for confirmation of his plans for mechanizing port grain elevators. Sergei took over his stepfather's working table, and pinned a sheet of drawing paper with the outline of his glider onto the drawing board. In OAVUK they were again trying to speed him up, everyone impatient to see what Korolev was constructing. As Kozyura and Faierstein had expected, all this business of designing was bringing about a transition of quantity into quality. The constructors' circles buzzed round the branch like bees in an apiary. Only the most energetic and persistent could be given attention and assistance. Everyone realized that to survive, the circles had to unite. So in June 1924 the BSGG—the Black Sea Glider Group—was formed, or rather a group of endlessly arguing Odessa lads who dreamed of flying gliders built with their own hands. George Ivanov, a ranter, but a very energetic fellow, who had brought a whole gang of his friends with him to OAVUK, was elected chairman. Sergei Korolev was made vice chairman and Kalashnikov secretary.

'First of all we must be quite clear,' Sergei said. 'We must know exactly how many we are, who is doing what, and where, and what he wants to do, and whether he has enough theoretical training for it, and whether he has the necessary production base, materials, and people. We should distribute our duties so as not to duplicate each other but to help everyone.'

A few years after the death of S. P. Korolev, G. P. Kalashnikov, Honoured Doctor of the Republic, said: 'Now I have suddenly realized that already in those years Sergei had an unusual ability to formulate tasks for people quickly and clearly.'

At the first meeting of the BSGG Sergei talked about his work on his glider. He was shy at first, feeling ill at ease talking about himself; then, looking round and seeing all his lads, he grew bolder and began to stop stammering.

Ivanov, who was himself designing a hydroglider, was putting questions in a jealous manner.

That was the very first public speech of aircraft constructor S. P. Korolev, the first of the thousands of such speeches that he was to make at all sorts of scratch consultations, briefings, councils, commissions, discussions, assessors' panels, post-mortem conferences, boards, committees, courts, and public meetings in the next forty years.

In the minutes of the first sessions of the BSGG it was recorded this way: 'Business: Com. Korolev's blueprints. Resolved: To ask Com. Korolev to complete his development of a landglider in the shortest possible time.'

Later the BSGG lads wheedled three old Gnome engines and the fuselage and wings of a crashed Farman out of what had once been the Anatra works. And like magpies they collected every bit of metal they found lying about and hid it away.

'As a reserve,' Sergei grinned. 'When we start building our planes we'll need everything.'

Leonid Kurisis was the first to give a talk at OAVUK about his glider. The drawings were pinned up and a pointer found. Many people came to hear his report, and knowledgeable people, at that: Faierstein, Lavrov, Borovikov, Seleznev, an instructor at the Railway Technical School, and Sergei's old acquaintances from HYDRO-3, Shlyapnikov and Dolganov.

Kurisis described his project. Faierstein fidgeted on his chair and could hardly wait for him to finish:

'It's marvellous! We ought to start building the glider immediately! We can start in the Yanvarsky workshops or on the Rifle Ranges where we built the glider from Arteulov's blueprints. The main thing is to get started!' Faierstein was ready to applaud any swallow so long as it was the first. He already saw the non-existent glider at the All-Union Rally in Koktebel, and heard the rip-

pled excitement and admiration: 'From Odessa! From Odessa!'

Lavrov poured cold water on him, pointing out that the design still needed work to be done on it. Suddenly Korolev raised his hand.

'I'd like to draw your attention to the shape of the glider's wing.'

Sergei spoke straight out, taking very little care to sweeten the pills of his criticisms, but without undue emotion, not hurrying, arguing each of his objections. People exchanged glances behind his back; no one had expected this from this quiet red-cheeked lad.

Dolganov supported him. It was decided to postpone construction of the glider, and to ask the author 'to modify his design in the light of the remarks'.

'Aren't you afraid that Kurisis will bury your design now?' Dolganov asked Korolev after the session.

'No, I'm not afraid. Maybe he'll prove sensible, but if he starts finding fault I'll fight back. I've made calculations, and figures speak louder than words.'

Those days Sergei often went to bed while it was already quite light outside. He was in a hurry to finish his glider. Sometimes Bozhko came to help him, and traced the drawings in violet ink, and shaded sections. He didn't have much interest for flying, or rather, he could not let himself take an interest in it, for he knew he couldn't fly. Nowadays one can design aircraft and never go up in them, even as a passenger, but in those years, when a man said 'I'm in aviation' it went without saying that he flew.

Usually Sergei was glad when Balanin went away on business, but now he missed his stepfather; many times he could prompt him and when he didn't know something would recommend a book, or a hand-book, a method of calculation, or a formula. It was on digging in books that lost Sergei most of his time. He would turn the pages furiously, whispering something to himself, then putting the

book aside, would start thinking impatiently, tapping a French curve against the table, and go on turning the pages.

At OAVUK they asked him about the name of his glider. They used to give gliders resounding, striking names: Dragon, Daedalus, Colibri, One Night.

His reply was 'K-5'.

The design was ready at last in July. Its presentation followed the same lines as Kurisis', ignoring the fact that Kurisis was a student at the Polytechnic (almost an engineer) and Korolev a tiler's apprentice.

There were criticisms, but they were petty. Then Kurisis rose: 'I think Korolev has made a mature project and that a glider can be built from it.'

Sergei's heart thumped. 'They'll build it!'

'Right,' said Faierstein. 'We must get Kharkov's O.K. immediately and build.'

'Labouring Man,
Build Your Own Air Force.

To the Central Sport Section

Enclosed are Korolev's glider project and an explanatory note. Please check the calculations and return as soon as possible.

Enclosures:
12 pages of drawings and explanatory notes.

Faierstein,
Chairman, Provincial Sport Section.'

At home Sergei again had trying conversations with his mother:

'What next?'

'What next? The next thing's to build, test, and fly.'

'Perhaps you'll think again about the Odessa Polytechnic?' she asked timidly.

'No. Rather than that I'll get a job in a factory.'

'There's no need for that, son. That means you're set on the Academy?'

'Yes.'

'But I've made inquiries. The Academy only accepts regular soldiers with experience and education.'

'I've finished school. And I have the glider.'

'All right.' His mother rose from her chair with determination, 'I'll go to Moscow, and Dad and I'll find out everything.'

She did go to Moscow, and managed to see a senior officer of the Academy, who listened attentively, and then asked:

'How old is your son?'

'Seventeen. Eighteen in... .'

'Young. Hasn't served in the army, has he? You know, our first year is made up of junior commanders.'

'He's finished a building school.'

'That's something.' He leaned back in his chair.

'And then there's this,' and she handed a piece of paper across the desk.

'CERTIFICATE

The Prov. Sport Section of the Odessa Prov. Branch of OAVUK hereby certifies that Korolev S.P., a member of the Prov. Sport Section, submitted the plan for the K-5 motorless aeroplane designed by him. The project has been submitted to the Aviation-technical Department of the Odessa Prov. Branch of OAVUK, and in accordance with resolution No. 4 of the Praesidium of AMO dated August 4, has been approved for construction and despatched to the Central Sport Section in Kharkov for approval. Com. Korolev submitted a detailed design—explanatory note to eleven sheets of drawings.'

'Oh dear, just what one would expect from those Odessa wiseacres,' he said smiling at the style. 'Well, that alters matters. But it's not in my power to accept your son for the Academy. Leave the papers with me, please. I'll report to the chief of staff. As soon as it is decided we'll let you know.'

She returned to Odessa with Balanin. Sergei, happy and proud, told him about the OAVUK meeting. Balanin listened attentively, but his mind wasn't on the glider. 'Perhaps, I was wrong when I insisted he should give up this aviation of his. It's a new rapidly advancing field, and he loves it, that's clear. The older one gets, the more inclined he is to measure the young ones with his own yardstick. Why? What for? They've got to go their own way.'

'So it's to be aeroplanes,' he said opening an emergency session of the family council. 'Well, if you've made up your mind on aviation, go on.'

'Uncle Yuri sent a letter,' Sergei's mother took a piece of paper from an envelope. 'By the way, he writes that Kiev Polytechnic has opened an aviation department, and he invites you to Kiev.'

She twisted it a little. It wasn't quite by chance that the letter had come from Kiev. She had written to her brother herself, telling him her worries. He had gone to the Polytechnic, obtained the necessary information, and written back to her.

'Kiev Polytechnic is a splendid institute.'

Sergei smiled. Balanin was a graduate of Kiev Poly himself.

'All right, accuse me of local patriotism,' Balanin laughed. 'But it's the truth. It has excellent professors and traditions.'

'But no traditions in aviation,' muttered Sergei.

'You don't know, so keep quiet,' his stepfather retorted. 'I've not seen it myself, but I've been told that Prof.

Delone had built a glider and flown it with his sons who were as mad on flying as you are. Why is there no aviation faculty in Odessa Polytechnic, but one in Kiev? Eh? No, my dear boy, in engineering something seldom springs out of nowhere, just by itself.'

'All the same I'd like to be quite clear about the Academy,' Sergei said frankly.

'I'm not sure you should wait for an answer from Moscow,' said Balanin thoughtfully. 'The more so as there's no guarantee it is going to be positive.'

Sergei could not settle down. He wandered around the town, sometimes went far along the coast and bathed alone among the rocks. One day in Arcadia he swam far out to sea and suddenly saw a woman's head not far away. When he looked again her head wasn't there! He almost got drowned himself as he pulled her up, limply clinging to his neck, and towed her and shouted until they were lifted into a row boat. She was brought round on the shore.

'Who is he, my saviour?' she asked in a trained theatrical voice. 'I want to see him.'

For no apparent reason Sergei felt sick and left.

That day at school he was handed a certificate:

> 'This is to certify that Korolev, Sergei, born 30 December, 1906, studied at Building Vocational School No. 1 from July 1922 to 16 August 1924. While attending the School he mastered all the subjects in the curriculum and has done practical work as a tiler.'

That was that. Now, good-bye Odessa! He felt depressed and lonely. After a summer packed with cases and worries, after the finals and the Med. Institute, and his project, he felt plunged into idle emptiness. For some days he had done nothing, absolutely nothing. And he wasn't used to it. The Kharkov bureaucrats were still holding up their reply. Work on the glider hadn't started. There

weren't any grounds for delay. A good engineer could sort it all out on a couple of hours. The Academy, too, was silent, and he was still waiting. The lads were running about like mad—Bozhko, Kalashnikov. Bauer already had all the papers for the Building Institute. Lyalya had been accepted at the Chemical and Pharmaceutical Institute. So she would be staying in Odessa—and he'd be going away.

They talked it over on the Torgovaya (Commercial) Steps. Sergei, damp, with red spots on his face, asked her to marry him. She replied that she wasn't thinking of marriage, that she wanted to study, that she must graduate and... . He didn't stop to hear the end, but rushed away.

The scene on the Steps was the last drop that overflowed the still so shallow cup of his patience. Not for anything would he stay in Odessa now. Not for anything! Moscow had not answered? O.K. He was not prepared to spend his whole life waiting for their answer. He'd go to Kiev. That was final. He had sent in his papers. He didn't need to take the entrance examinations, the Building School certificate exempted him.

He packed quickly. For what did he have to pack? He would have liked to take the ink-stand made from a cartridge-cases as a reminder—a present from a lad at the power station—but thought better of it; it was too heavy. The suitcase ended up quite light—the first suitcase in his life. In later years he always travelled light, in 1938 and in 1961. His mother and stepfather came to see him off, and said the usual things:

'Dress warmer, it's nearly autumn... . Don't forget... . Write us... .'

The last thing he saw on the platform was his mother's face, in tears. She walked quickly after the train. Behind her a red slogan gleamed: 'Factory smoke is the breath of Soviet Russia'.

Afterward he sat on the seat looking out of the window

at the yellow fields of maize. What was in store for him in Kiev? And later on? Wings. This was a must. There'd be wings, there'd be the sky. There'd be life.

CHAPTER 9

He discovered Kiev all over again. It didn't seem a long time since—seven years—but still he couldn't recognize a thing. No, of course he recognized something. It was here on Nekrasovskaya St. that he had run in a 'cossack charge' of the local kids after a gang of 'robbers'. And Proreznaya Street, he remembered that, and the Galitsky Market, and Trukhanov Island—of course, he recognized it the instant he saw it. But his memories seemed to come not from past reality but from a distant forgotten dream. Seven years, that's a vast age at seventeen.

Sergei received a warm welcome.

'Isn't he tall!' cried Uncle Yuri. 'What a surprise! Maria wrote: "Meet Sergei." Well, I imagined him a black-eyed, long-haired little chap with a lace collar, a real Lord Fauntleroy, and he turns out to be a full-grown man, an Odessa docker!' He patted his nephew's broad back, shoved his shoulder starting a clumsy awkward scuffle, the most sincere way men have invented of expressing friendly feelings.

Uncle Yuri lived on Kostelnaya St., a green lane running steeply up from the Kreshchatik. The flat was small; it had three rooms: one bed-room, dining-room, and nursery. Sergei was given a sofa in the dining-room, which was in between the other two rooms. He liked the sofa: it had a soft back into which one could cosily push one's nose, but he decided at once that he was not going to stay at Uncle Yuri's. He didn't want to be a nuisance, but the main reason was not so much his tact as his acute desire, now that his mother and Grigory were far away, for complete adult independence, a desire to have a key of

his own in his pocket, to come and go as he pleased, to read till daybreak, to sleep all day, if he fancied it, and to walk at night.

But he didn't say anything to Uncle Yuri, deciding: 'First I'll settle things at the Poly, then I'll have time to think about digs.' His first preoccupation was to find out if everything was in order about his enrolment, and discover everything there was about the aviation course.

For three kopecks a tramcar, rattling and creaking like a ship in a storm, carried him swaying from side to side along Bibikov Boulevard from the Kreshchatik to a wide, spaciously planted park whose trees blocked the view of a large building in expensive yellow brick. The central block, three storeys high, with little turrets at the corners and fancy cornices, had an extension in the form of two-storey wings that enclosed a lawn already beginning to turn yellow.

Glancing at the wide, slightly bay, windows with a builder's eye, Sergei appreciated the architect's idea; he had obviously thought about the purpose of the building, and tried to provide as much light for the classrooms as possible. Sergei corrected himself immediately—not for the classrooms, but for lecture rooms, for this was Kiev Poly.

Yes, this was the Poly, the Rakovsky Polytechnical Institute, where he had sent his papers from Odessa. In the tram he had wondered if some piece of paper might surely be lacking, that he would certainly be required to provide additional proof that he was Korolev, S. And so it was. The Vocational School certificate indeed enabled him to enrol without taking the entrance examinations, but in order to entol, it turned out, he needed a permit as well. He couldn't imagine what the permit was.

'You can get one from the provincial office of the trade union,' a woman secretary in the rector's office informed him. 'You are a member of a trade union, aren't you?'

'Who ever's not a member of a trade union is a parasi-

te,' Sergei recited the slogan popular at the time with a smile.

She didn't laugh, but took a piece of paper from her desk.

'Now write an application, a detailed one, stating the reasons why you want to study here,' and she handed him the paper. Sergei sat down at a table, thought a little, and began writing.

'To the Kiev Polytechnical Institute from Korolev, Sergei, graduate of the 1st Building Vocational School

Application

Please enrol me in the K.P.I. This year I finished the 1st Building Vocational School in Odessa... .' What more should he write? He stabbed with his pen at the inkwell and went on: 'Spent a period of practical building work as a tiler's helper... .' That was a good idea: 'spent a period of practical work'. What period? How long had it lasted? That remained obscure. Incidentally, why am I all the time stressing on my building profession? I'm going to be an aviation engineer, so why should I write about tiles. 'Worked for a year and eight months in the Provincial Branch of the Society for Aviation and Ballooning, took part in the work of the constructor section of the aviation-engineering department.' Now that carries weight. Perhaps, I should write about the glider. Why not? After all I didn't steal it. I'll write the whole story. 'I have designed a glider of an original K-5 system. The project and the drawings were approved, after checking the calculations, accepted by the OAVUK Branch and approved for construction, and sent to the head office in Kharkov.' I'll write about the circles, too. Make the story complete. 'In addition, for a year I have been leading workers' circles in the port and in two factories. All the knowledge of higher mathematics and aeronautics needed I

taught myself, profiting only by a reading list compiled for me by the experts of the engineering section of OAVUK.' That'll do. Let them know who they're dealing with. But how to finish? Will this be all right? 'In view of the above I beg you to give me the chance to continue my technical education. I enclose the following documents... .' He drew up a neat list of all his papers.

He journeyed to the Poly nearly every day; he had no friends in this strange city, and then there was always something to write, forms to fill in, medicals to pass. There was still no reply to the urgent inquiry sent to Odessa and he began to get worried. And then he was given yet another paper to fill in. This time it was a questionnaire. He got as far as *Nationality* and began to brood over it. In fact, what was he really, by nationality? His father was probably Russian, and Mama? Granddad, well, he was Ukrainian, there was no doubt about that, and, of course, Grandma, too. That makes mother Ukrainian. And what about him? Was he Russian or Ukrainian? At home they spoke Russian. With the boys he spoke Russian, too. All his lessons had been in Russian. He took lessons in Ukrainian, but spoke it badly. He could write one or the other. In the end he wrote 'Ukrainian'.

Social status. He underlined: 'teacher', and added 'lecturer'.

Main profession: 'Lecturer-stenographer'.

Public and political activities: 'From June 1923 an active leader of workers' circles in three Odessa factories and at the Naval Base'.

Source of livelihood: 'Lecturer's fees'.

How long have you been earning your own living: 'Three years'.

Last place of work: 'Provincial Branch of OAVUK'.

Have you any means, for how long, how much: 'Available until November of this year'.

Are lodgings available near the institute: 'Yes'.

His answers, written in Ukrainian, presumably to make the nationality reply more convincing, the naive 'lecturer-stenographer', the indiscreet 'active leader', the little white lie—wherever did he get that 'three years' of independent working life from? It all spoke of such a burning desire to remain in this spacious brick building, to begin 'independent working life' in earnest, and to convince all the judges deciding his fate, still strangers to him, that the boyish down on his rosy cheeks should not prevent him from making good.

Sergei Korolev was one of the youngest prospective candidates for the Kiev Polytechnical Institute. There were few so rosy-cheeked or youthful. Before the Revolution there were what were called 'eternal students' who managed to retain the status of student for ten years or more. The imperialist war, followed by the Civil War, completely broke down the normal routine of the educational process, delayed it, and in some places brought it to a complete standstill. The first intake at Kiev Poly after the Revolution was in 1920. But some of the 'old 'uns' still remained. Before 1922 the course was a three-year one, and then became a four-year one. In 1921 a 'Rabfak'* and preparatory term were organized. Korolev enrolled at the same time as a group of Rabfakists of the 1922 intake. Many of them not only had not had the opportunity of studying the history of Greek drama or strength of materials, like Korolev at his Odessa school, but two years earlier had not even been able to read. They were workers and peasants, former soldiers, who had come to students' desks straight from the flames of the Civil War. Here at the Poly they were all mixed together—the 'professional' students in worn student uniform of Tsarist days, wearing pince-nez, ironical, supercilious, and exceptionally lazy; the

* Rabfak, or Workers' Faculty, was a special evening course giving young workers a crash course of secondary school level and preparing them for entry to the higher educational courses.—*Tr.*

Rabfak intake, healthy, gauche, still very much in the dark, but seizing books in an iron grip with an indestructible love, or rather passion for knowledge; and various people seconded to fill the places allotted to the trade unions. They included callow youths and quite good, already established skilled workers—engine drivers, mechanics, gangers, people with industrial experience and seniority. And there were also the young sons of Nepmen*, with the way of Russian merchants, which they fobbed off as aristocratic, a little gang of easy-going, well-fed young men, slicked with brilliantine. But for all this variety of social position and differences of human destiny, students like Korolev coming straight to college from school were in the minority. What would become normal in five or ten years' time was then considered the exception. Seeing no one of his own age, and knowing that he was unlikely to meet lads like Valerian Bozhko and George Kalashnikov here, Sergei became, not exactly dispirited, but rather down-hearted. The sense of injury from the Commercial Steps was soon forgotten. He had written a long, circumstantial letter to Lyalya and was impatiently awaiting an answer. Every morning he put his hand into the letter box and fumbled about, always thinking the letter might be stuck there, caught in a crack and refusing to come out.

Never having been a sociable person he became quite withdrawn during his first weeks in Kiev, wandering alone about the spacious but still unpeopled building, peering into the lecture rooms and laboratories, inspecting, trying to get the feel of the new place. But he wouldn't have been Korolev if this process of lonely habituation had gone on indefinitely. Over-charged with energy he yearned for creative contacts so as to devote his energy to work.

* Nepmen were people who had profited from the capitalist activities permitted in Soviet Russia under the New Economic Policy (NEP).

That autumn a small but very interesting aviation exhibition was held at the Poly, which immediately caught his attention. Looking at the exhibits he remembered his stepfather's words about aviation traditions and became convinced that Balanin had been right.

It turned out that the first aeronautic circle at the Poly was organized in the year Korolev was born, in 1906. Its vice-chairman was then a student at the Poly, Victorian Bobrov, who became rector in 1924. In 1909 Prof. N. B. Delone, one of N. E. Zhukovsky's gifted students, and his sons had indeed built a balanced glider, a biplane, and flown it. He had even published a slim booklet *How to Build an Inexpensive Light-weight Glider and Learn to Fly It.* Delone had been fascinated by a public lecture by Zhukovsky who had come to Kiev in the autumn of 1908. It was the time when the Wright brothers' plane had already made its flight and everyone was talking about them. The attendance at Zhukovsky's lecture was so big that people were standing in the aisles. The lecture was interrupted at times by the dry rattle of a cinematographic apparatus with Count Zeppelin's airship floating across a white screen, and Bleriot's and Farman's planes running jerkily. Among the wonders shown was the aeronautical competition held at Bordeaux, Wilbur Wright's flight, and the aeronautical park in Paris. Delone was not the only one carried away by his teacher's ideas. About the same time Alexander Kudashev, who held a personnel professorship in the chair of structural stability of Kiev Poly, had built four planes. They were of quite a successful design, powered by engines of 25 to 50 horsepower. The passion of the teachers for aeronautics was passed on to the students. They had formed groups, designed planes together, and built them. Quite large sums of money had been needed to buy the engines and materials, and the student-aviators would have been very hard put to if Fyodor Bylinkin and Igor Sikorsky hadn't been among the enthu-

siasts. The former was the son of a rich merchant, and the latter of a prominent Kiev psychiatrist and professor. They managed to obtain the money to build the planes and had arranged a special workshop on Kurenevka St. The workshop grew so quickly that it even took orders for planes from outside. Bylinkin built planes along the Wright brothers' lines, and Sikorsky who had early guessed his future fame as a leading constructor had acquired a passion for building helicopters, though they failed in tests because they had no tilting mechanism and no controls. A third student Iordan was also undoubtedly a gifted designer; he did not have a rich father, but he had an inventive head and clever hands. Bylinkin and Sikorsky built several planes of their own design, and two BIS planes (Bylinkin, Iordan, Sikorsky), the fruit of their joint efforts.

Aeronautics had rapidly become the rage in Kiev. The financial support given to the young aviators by wealthy people became a badge of tone, a sign of a progressive outlook and boldness in business. To keep up with the times Karpeka, a wealthy sugar refiner, had encouraged his son Alexander's passion for flying while he was still at school, and the latter, too, built three planes. Another millionaire sugar refiner, Tereshchenko, straining not to lag behind his rival, also began building planes. What counted most—sincere interest, jealous vanity or business acumen—it is hard to say, but in any case the aviation boom in Kiev in 1909-11 was certainly a progressive phenomenon, at least from the technical point of view, if not from the ethical, and made it possible to speak of the Kiev school of aircraft constructors. 'Their road took the Kiev constructors from their first flights of 1910 to the building, years later, of the giant aeroplanes *Russian Knight* and *Ilya Muromets*, unprecedented for their time,' V. B. Shavrov, the historian of Soviet aviation, writes.

As young Korolev inspected the exhibition it became

clear to him that the introduction of a course in aviation in the engineering faculty had not been sheer chance, but that the isolated efforts of talented individuals depending on rich sponsors for support had to be replaced by a group organized and financed by the Soviet authorities.

And the group already existed. Its guiding spirits were the rector of the Poly, Bobrov, Prof. Delone, Prof. D. A. Gravé, member of the Academy of Sciences, and Profs. Staierman and Sineutsky. Their initiative had evoked enthusiastic support from the rank and file; among the students there were quite a few with an earnest interest in aviation, including several former pilots. Deserving mention because of their forceful drive are Konstantin Yakovchuk, Dmitry Tomashevich and Nikolai Zheleznikov.

The laboratories and workshops of Kiev Poly had been severely damaged during the years of war and disruption. They had to start from scratch with the minimum of funds and materials. But they started! And they did it! While Sergei Korolev wandered lonely and unknown to anyone around the premises, feverish preparations were in progress to send off the first-born of the glider circle, the KPIR glider, to the Second All-Union Glider Rally in Koktebel. As one would expect Sergei lost no time in joining the circle. He cherished the faint hope that he, too, might perhaps be able to go to the Crimea and see the best gliders, meet famous pilots, and (which was the main thing) to learn to fly a glider himself. Fighting down his shyness he told the circle about his project, but soon realized that no one was interested in his story, and that the project, which they knew nothing about, and which was gathering dust somewhere in remote Kharkov, was nothing to them compared to the glider with the awkward high tail, and the wheels right under its belly that they had built with such difficulty and which was now to reward their labours in the Crimea. Korolev's timid hints about his desire to go to the Crimea either passed unnoticed or elicited smi-

les; those willing and deserving to go, since they had spent days and months below the stairs of the central hall and under the awning in the quadrangle where the KPIR was built, were too numerous. No, there was no hope of Sergei's going to the rally with the Kiev lads, and he knew it. Was he going to miss the second rally, too? That's too much! The last time they had sent Kurisis, and he had brought back blueprints of Artseulov's glider. Lord, he would bring back all the blueprints they wanted to choose! But how was he going to get there? He hadn't enough money to pay for a single ticket. His one hope was Odessa. Perhaps his old friends would take pity on him. On the August 20th he wrote to Faierstein in Odessa:

'Dear Mr. Faierstein! Reminding you of your words at my departure I would ask a favour of you: please arrange to send me to Feodosia for the glider rally. A large party is going from Kiev but I, as a freshman, cannot press to be sent from Kiev. So I risk not being able to see the rally this year, too. Visiting it would give me a great deal and I would be able to work with great success in the field of aviation and gliding. I hope the Odessa Provincial Branch of OAVUK will find it possible and expedient to send me to the rally remembering my former work in conducting glider circles. Besides, the trip would help me to arrange some personal matters and raise the prestige of the Odessa Provincial Branch in Kiev. I enclose for a reply stamps and hope to receive an answer as soon as possible at the following address: Kiev, Kostelnaya St. 6-6, c/o Moskalenko for S. P. Korolev. By the way, I shall finish my business by 27 or 28 August and will be able to leave for Feodosia on the 30th. If it comes off, please, inform me of the details: where and how the trip will be arranged.

Yours, sincerely S. Korolev.

P.S. I'm interested to know what is the fate of my project and drawings? S.'

Of course, Faierstein was also a forlorn hope. What was Korolev to them now? Out of sight, out of mind. In short, he was sitting between two stools.

Sergei was on edge. Everything was so uncertain. A few days later his papers arrived, and that calmed him down a little.

'*Ukrainian Soviet Socialist Republic*
Kiev Provincial Branch, Union of Educational Workers Ref. 10519 *August 19, 1924*

Certificate

Issued to Com. Korolev, Sergei, member of the Union of Educational Workers, card No. 13266, to certify that he is being directed to the KPI to fill one of the places allotted to the PCTU*... .'

And just in case, remembering that an additional piece of paper does no harm in affairs of this kind, he got hold of yet another document.

'*Kiev Provincial Council of Trade Unions*
Palace of Labour, 31/33, Korolenko St.
Ref. 2959 *August 19, 1924*

To the KPI.

In view of the definite progress of Com. Korolev in the field of aviation the Admissions Commission of the PCTU has nothing against his working experience of only $1^1/_2$ years being counted as seniority for his admission to the appropriate faculty of the KPI.'

To Korolev's delight, the responsible secretary of the Provincial Branch of OAVUK added a postscript in Ukrainian to this document:

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* Provincial Council of Trade Unions.

'To the KPI. I am of the opinion that Com. Korolev should be admitted to the Mechanical Engineering Faculty of the Institute. An additional reason is that most of our glider builders will soon be graduating. It is also necessary so that the activity of the glider builders, which it is so important to support, will not be held back, but, on the contrary, will develop rapidly in the interests of our aviation industry.'

That was nice. They'd recognized him as one of their own kind, a glider builder. Just wait, he'd still show them what he could do.

Those autumn days of 1924 were the time when Sergei Korolev, unsettled, almost penniless, full of hopes and fears, really began his own independent life. Often the development of his ideas and the realization of his plans depended on the desires and will of others, but he never subordinated himself to the desires and will of others. When a man sets himself such a course he often, more than others who are less staunch and firm, has to experience the bitterness of disillusion, but the disillusionment, on the other hand, does not wound him like the others.

Here, for example, is Faierstein's reply. How eagerly he had waited for it! He hastily tore the blue envelope open.

'Com. Korolev,

'In regard to your trip to the All-Union Rally there are definite rules according to which the committee of OAVUK selects comrades for competitions, who are available at the Provincial Sport Section.

'We have already made this selection, and some of the participants have already left for Feodosia. The rest leave on August 30.

'All the places allotted to the Odessa Provincial Sport Section have been filled, funds for additional

tickets have not been granted, and therefore your request cannot, I regret, be met.

Faierstein,
Chairman, Prov. Sport Section, member of committee of the Odessa Prov. Branch, OAVUK
23/25 August 1924. Odessa.
No. 2362.'

So. Everything's clear. He folded the letter. It's quite clear, but why did he have to write so officially, so callously? What's all Faierstein's boiling energy worth, all the heat of his platform speeches, if he does not see the simple human being? Of course, there's no money. But couldn't he have written: 'Sergei, there's little cash. To send you means to offend the other lads who are just as keen to go as you are and who deserve the trip no less than you do... .' That's all. He'd have understood. But why all this 'available', all these titles 'Chairman', 'member of the committee'?

So, it was all clear. He was not going to the Crimea. His programme for the next year was to study, to build gliders and to get to the third rally, cost what it might to find a source of income, and lastly to find new digs so as to be able to say goodbye to Uncle Yuri's couch.

CHAPTER 10

Sergei Korolev's student life had little in common with the life of students today. Present-day students may experience delights forbidden to him for, on the whole, it was an immeasurably harder life. It is difficult to imagine student life without balls and carnivals, big sports meetings, amateur dramatics and choirs, and seats in the gallery, without friendly parties and gay dances.

Korolev's life was quite different. To begin with, all the first-year students at Kiev Poly in 1924 had to appear before a special commission which divided them into categories. The first category included workers and peasants and the children of workers and peasants. They were not have to pay fees. The second category, to which Korolev belonged, consisted of representatives of the working intelligentsia. They had to pay for their studies. The sum depended on the income of their parents but did not exceed 40 roubles. The third category, the children of Nepmen, had to pay quite large fees. Among the first- and second-year students only those from Rabfaks received grants.

So the problem of his social origin, which had never before interested Sergei, became a very acute one. In later years, at the Moscow Higher Technical School, he felt more than once that the lack of 'proletarian origin' hampered him. There were people who were always ready to accuse him of 'intellectualism', to substitute verbose tirades about his 'class deficiency' for arguments about technical principles. But it was only later that he discovered the real social and political meaning of this phenomenon. Just now his inclusion in the second category meant only additional expenses. The question immediately arose: where was he to get the money to pay for his fees? Fees, not food, or lodgings, or clothes and amusements, came first.

He had a postal order from Odessa for 25 roubles, but he knew he would not be receiving such remittances regularly. Besides, he didn't want to receive them. The postal order delighted him, but at the same time made him suffer because it eroded his hopes of an independent life. He had somehow to find a job. And in those days that was not easy. The workshops of CISLC, the Committee for Improving Students' Living Conditions, could not provide work for everyone who wanted it. Sergei spent several days running about wet streets strewn with yellow leaves before

he succeeded in finding a job. There was a newspaper dispatch office on the corner of Vladimirskaya and Fundukleevskaya Streets, and Sergei took on the job of delivering newspapers to newsstands.

He had to get up early, when the streets were still pitch dark, and it was hard to believe that it was dawn. He dressed by feel, shoved a packet of bread and fat bacon, packed in advance, into his pocket, and tip-toed with his hands in front of him out of the sitting-room. Still half asleep, he would stumble into a chair, or a table, and the china would rattle, and he would halt for a moment and then start on his way again—down the steep slope of Kostelnaya St., across the square, down Sofiiskaya St., left into Vladimirskaya St. and there he was, diving into the noisy, light warmth of the basement and the sharp smell of the printing ink; so pungent, that he even felt it with his eyes was the smell of seaweed thrown ashore by storms on Austrian Beach.

In a letter to his mother he wrote: 'I get up early in the morning, about five o'clock, run to the newspaper building, fetch the papers, and then run to Solomenka St. and deliver them. That way I earn eight roubles. And even think of renting a corner.'

Several lads worked in the dispatch office, and Sergei very soon saw that their work was badly organized, or rather, was not organized at all. Often two of them worked the same route, some staggered along overloaded while others ran with light loads. He got the lads together organized a team and worked out routes. Everyone liked it. He apparently had a certain inborn talent for organizing, which always showed up throughout his conscious life in big things and little ones. He simply couldn't stand aside when he saw something not being done well, that could be done better, more economically, more rationally. Sometimes he made himself ridiculous. Once, in the autumn not long before his death, Korolev watched the grounds

round his house being swept and cleaned. He looked at the growing heaps of rusty leaves, deep in thought, and then, unable to restrain himself, stopped the work; only when he had stationed everyone so as to fit some abstract scheme was he finally satisfied.

Extra earnings like Korolev's were no exception in the life of students in his days. On the contrary, they were the rule; the bulk of the students in Sergei's year earned money some way or another. And of course it radically affected the rhythm of their studies. To-day there are evening courses for those who work and study at the same time. Then almost everyone was working, everyone was an 'evening student', classes did not begin at the Poly until four o'clock in the afternoon and went on till ten in the evening.

The classes were rather different, too. No marks were assigned. There were no examinations. Lectures were read, and during them the lecturer might put questions to the students. It was somehow half-way between a lecture and a seminar. There were also seminars, during which the lecturers found how the material was being digested and at the same time explained some of it. So they were half-way between seminars and lectures. Finally, the students had to pass tests that actually only differed from exams in there being no marks. But don't think it was easier that way. During the two years he spent at Kiev Poly Korolev had twenty seven tests in higher mathematics, physics, chemistry, mechanics, strength of materials, thermodynamics, machine parts, electricity, architecture and building, statics, and political economy, presented the results of practical work in most of these subjects and of his work in the workshops, lubrication laboratory, and of his summer practice in geodesy, and finally did practical training in Konotop, working as the fireman on a locomotive.

To complete the picture we may add that the spirit of experimentation, that we already encountered at the Odessa Building School, also permeated the higher schools. Even

when there were rigorous curricula there was great freedom within their framework for choosing the way to implement them. Very many professors and lecturers were working out their methods and testing them in practice. The teaching staff of Kiev Poly were no exception. And all that, as you will readily understand, did not make the students' lot any easier. At the first lecture, when the whole course assembled, Sergei saw that his misgivings about his youth were justified. It seemed he was the youngest of the lot. Around him sat men in faded army tunics, shabby sailors' pea-jackets, worn workers' padded jackets. Sergei glanced sideways at his neighbour, a brawny fellow with a moustache and a silk scarf wound round his neck. His hands were obviously a worker's. During the break he approached him.

'Let's get acquainted.' He held out his hand. 'My name's Korolev.'

'Mine's Puzanov, Mikhail.' The man with the moustache eyed Sergei, and then asked: 'Haven't I seen you around before? Where are you from?'

'From Odessa. And you?'

They talked. It turned out that Puzanov had worked before the Revolution in the Poly aeroplane shop. Later he had worked in a factory. And during the war he had been sent by the army to work in a machine shop in Grushki. In 1922 he had entered a Rabfak and now, having finished it, was in the engineering faculty at the Poly.

'There are a lot of our Rabfak people here,' he told Korolev. 'That one over there is Yakov Bovsunovsky. That is Krasovsky. He came from the country. And Sakhnenko, the dark man over there, worked as an engine driver.'

'He's old enough to be my father, that Sakhnenko,' Sergei thought.

'That one over there is another engine driver, Fyodor Vaskovsky.' Puzanov nodded in the direction of a stout man of forty-five. 'He used to live in Harbin under police obser-

vation, but it was Petlyura who arrested him. Ever heard of the armoured train "The International"? He drove it.'

Korolev liked Puzanov. He was more literate and better educated than the rest, and besides, he had an innate delicacy, or modesty. Sergei did not like pushing, restive people. Most important, however, was the fact that Mikhail, too, had a passion for aviation and already had some experience. He told Sergei about the Kasyanenko brothers, who had done much to organize the course in aviation on their faculty. The most energetic of the brothers was the younger one, Evgeny. He had organized the aviation workshops at the Poly, which were headed by his brother Ivan. At first the shops produced only propellers but later Evgeny and Ivan, with their third brother Andrei, began designing and building planes. One of them, a small monoplane with a 15 horsepower engine, was test-flown on the Kurenevka by P. N. Nesterov himself. Up to 1921 the brothers had built six planes of original design, almost every one of a different type.

'And all our machine tools are left over from the brothers,' Puzanov concluded.

Puzanov was almost nine years older than Korolev, but they soon became friends. What Sergei liked about this working lad was that he wasn't just concerned with obtaining a degree as soon as possible, as many others were, but with gaining knowledge, and studied hard.

On the first Sunday in October he and Mikhail went to the airfield, where the ceremony of laying the foundations of a hangar was to take place. The Kiev branch of OAVUK held a meeting and talks on the history of aviation were given right on the field. There was a big crowd. Suddenly Sergei caught a glimpse of a familiar face.

'Heigh! Ivan! Is it really you?!' he shouted.

Before him stood smiling Ivan Savchuk, a pilot-observer, or navigator as he would now be called, from HYDRO-3.

Sergei was very glad to meet him. It couldn't be said

they were friends, but Ivan was now part of Odessa to him, of the sea, his home, his boyhood that he had left behind there.

It turned out that after the squadron had been transferred to Sevastopol Savchuk had come to Kiev. 'We're neighbours,' he said. 'I'm living at the pilots' quarters. It's quite near your Polytechnic. Come over to my place!'

Sergei could not help envying Savchuk. The pilots' quarters at the edge of the airfield were solidly built brickhouses, with central heating. And each pilot had a room to himself. They also had a canteen with excellent food that had nothing in common with the watery stew they called Blue Danube at the Institute, with two bits of pearl barley floating in it that you couldn't fish out with a spoon. And the planes here—as one took off, another landed.

'Will you take me up?' Sergei asked greedily without taking his eyes off the plane.

'Oh, no,' laughed Savchuk, turning his head toward a man with a lean handsome face who had entered the room. 'This isn't a 'Nine'. It's a Nieuport, a fighter! Where am I going to find room for you? Ask Alexei. Nothing's impossible for him. He'll put you on the propeller.'

Alexei Pavlov, a friend of Savchuk's, was a reckless dare-devil of a pilot. Anticipating events a bit, I'll tell you here and now that he was killed fairly soon after this encounter. Apart from being an excellent pilot, sure of his talent but already poisoned with recklessness, Pavlov was also a gifted designer. On the eve of Korolev's departure from Kiev, to prove a point in a stupid argument, he flew under the Bosch Bridge. For that offence he was sent as an instructor to Serpukhov, near Moscow. There he built a baby plane from his own drawings, and learning about the ceremony that was to take place at the Central Airfield in Moscow to mark the transfer of twenty planes from Osoaviakhim to the Red Air Force he flew it to Moscow.

He put his little plane through a shower of stunts; when

it remained only to make a good landing, he suddenly crashed, intoxicated by his absolute control of the little manoeuvrable craft, head into the ground. Korolev kept a cutting from *Izvestia* (23.7.28) with the news of Pavlov's death to the end of his days. Pavlov was handsome, negligent, quick in his movements and full of a soft, kind charm that made people fall in love with him the first time they met him.

Sergei and Mikhail became frequent visitors to the pilots' quarters. Sergei tried persistently to talk the two pilots into enrolling at the Poly as external students. At first they waved it lazily aside, then thought, why shouldn't they? What did they risk if they did?

Soon all four were to be seen together at lectures. They prepared for tests together in the pilots' quarters. Korolev said that they should think out a more effective method of studying. 'One of us should take on the job of the tutor in a certain subject and advise, check, find who doesn't know what,' he argued.

After a few arguments they adopted his method. Subjects were distributed on a voluntary basis. Korolev, Prof. Siminsky's favourite, was responsible for strength of materials. Puzanov led the courses in physics and electricity, Pavlov in political economy, and Savchuk in descriptive geometry and machine parts. Savchuk was also senior consultant in German. His father had been a diplomat, and before the war he had spent several years in Berlin and spoke and wrote German as fluently as Russian.

The pilots received ample rations and on the sly fed Sergei Korolev and Mikhail Puzanov; the latter had even contrived to earn some money by tutoring the airfield commander Malyarenko in mathematics.

All the four studied hard and persistently, especially Korolev and Savchuk, and these two often had long 'philosophical' discussions. Even Pavlov's guitar could not stop them.

So they pored over books and abstracts, day after day,

one like the other, except that, occasionally, on their day off they would visit the Schanzer Cinema on the Kreshchatik.

Toward the end of the autumn Sergei's mother sent him the reply that had at last come from the Air Force Academy. Permission was granted for him to enroll provided he passed examinations in military subjects obligatory for all cadets before December. The same envelope contained a note from his mother. She advised him not to make a hasty choice, wrote that a military man was not master of his own life and that, as he was already studying the subjects he was so keen on, it wasn't worth breaking off.

At Sunday dinner at his grandmother's, Uncle Yuri and a young cousin of his mother's Alexander Lazarenko also tried to dissuade him from going to Moscow. His grandmother sat close to him, embraced him, and spoke tenderly to him, stroking the black locks on the back of his head with a kind hand.

'Now, why do you want to go there, grandson? You haven't anybody there. Your mother writes she's thinking of moving to Moscow next year. God grant, she'll get there, and then we will start thinking about it. I'm an old woman, and you shouldn't desert me.'

His grandmother had aged considerably after his grandfather's death, but still persistently refused to accept help from her sons and daughters, her Cossack pride refusing to accept the weakness of old age.

'What am I to do?' thought Sergei. 'Should I go, or should I stay?' Somehow he didn't feel at home in Kiev, regarding himself as a stranger from another town, though Kiev, more than Odessa, could claim the honour of being his home town. He could not bring himself to dispel the notion that his life there was a brief episode and felt he would not stay there long. He constantly felt a hidden unease, and an inner voice spurred him on, he knew not where. He often tried to imagine what Moscow looked like, and

would begin to tell Puzanov, as he used to tell Kalashnikov in Odessa, about the young and already famous constructor, Tupolev.

Mikhail Puzanov even said to him once: 'Don't fret yourself, go to Moscow.'

But to be quite frank he wasn't very keen on a military career. The advantage of the Academy lay in the fact that aviation engineering was the main subject there; while at Kiev Poly it was the same as at the Odessa Building School —mathematics, strength of materials, physics. It would take them a long time to get to planes. On the other hand, after the Poly you were your own master; you could do anything you wanted, and go anywhere you liked. Take Sikorsky. He didn't take his degree at the Academy.

Korolev told Ivan Savchuk about his doubts.

'Don't skip off,' Ivan said sternly. 'Having chosen a job stick at it and don't skip off. You're young, you'll have a chance to go to Moscow.'

Korolev wrote back to Odessa that he was going to stay on in Kiev.

He went home for the New Year, or rather he went to see Lyalya, and spent several happy days in cold uncomfortable Odessa. He thought they were unhappy then because Lyalya was, well, quite indifferent and cold; yes, she was, indeed, he saw it very well. It took him several years to understand how happy they had been, and to understand her glance that New Year's Eve.

CHAPTER 11

In 1925 something happened in Kiev that we would like so much to link with the fate of our hero, that we must keep a firm check on ourselves to resist the temptation and stick strictly to the sparse list of known facts.

In April a Poly graduate, a pilot and an enthusiastic propagandist of aeronautics, Alexander Fyodorov, organized

'a circle for world space studies' under the auspices of the Inventors' Section of the Association of Engineers and Technicians. Fyodorov corresponded with K. E. Tsiolkovsky of Kaluga. 'I deem myself lucky to be able to work under the guidance of the creator of great ideas, the thinker of our time and expounder of great and unfathomable truth!' he wrote in rapture. His enthusiasm found support; the membership of the circle rose to 70. D. A. Gravé, member of the Academy of Sciences, became Chairman of the Circle's scientific council; B. I. Sreznevsky, another member of the Academy, became vice-chairman. The board included many prominent Kiev scientists and engineers, among them members of the staff of the Poly like K. K. Seminsky, V. I. Shaposhnikov, and E. O. Paton. (In four years' time this famous bridge-builder was to begin his fundamental work on electric welding. Years later his son Boris, President of the Ukrainian Academy of Sciences and director of the Institute of Electric Welding, would head the 'Vulcan', project for the first apparatus for welding in outer space, carried out in Kiev and tested on the space vehicle *Soyuz-6* in October 1969. The succession of generations is talked about so much that it sounds hackneyed, but here, nevertheless, was a real and brilliant succession!)

On June 14, 1925 Prof. Gravé published an Appeal to Circles for the Study and Mastering of Outer Space. 'Circles for the study and mastering of outer space are encountering a rather sceptical attitude in many public circles,' it said.

'People think that it is a matter of fantastic, unsubstantiated projects for flights into interplanetary space in the spirit of Jules Verne, H. G. Wells, or Flammarion, and other novelists.

'A professional scientist, like a member of the Academy, for example, cannot take such a point of view. My sympathy for your circles is based on serious considerations... .

'It follows that the setting-up of such circles is both timely and expedient; that is also true of the development

of interplanetary apparatus. For that reason I heartily endorse every kind of initiative in this field and wish you success and fruitful work in the development of this new branch of engineering for the good of mankind.'

The 'Appeal' provoked a wide response and heated debates at the Poly, which were intensified by the opening five days later in the building of the Museum of Revolution on Korolenko Street of an exhibition of interplanetary space studies. The exhibition remained open for two months.

Could Sergei Korolev, a young man with such passion for aeronautics, a student of the Poly, whose teachers were at the head of this new initiative, be totally ignorant of it? It is very hard to think so. But there is absolutely no evidence, direct or indirect, of his interest in the activities of the newly organized circle, which was re-organized in August of that year into the 'Society for the Study of World Space'. Korolev was not yet able to bring together the technological reality of those years and fantastic dreams of interplanetary flight. To do that he would have had to read Tsiolkovsky's revelations, to believe in the passionate conviction of Zander, to learn of the work of Goddard and Oberth, to see the boundless horizons that the rocket would open to him. At that time he knew for certain that he could build a glider himself and fly it, but it was impossible for him to imagine himself building an interplanetary ship. Being a matter-of-fact person, with a concrete mind, he could not run ahead of himself. He was called to the cosmonautics summits before he had seen the foothills. He would have to find his own road there.

We may, however, conjecture that the Kiev 'interplanetaries' might have been able to influence his choice of path if they had not been about two months late with their circle. For on February 15, 1925 a course for glider instructors was organized at the Poly. Many wanted to enrol since not only the Poly students were eligible, but the members of glider circles as well, and there were plenty of them in Kiev. Even-

tually, after great disputes, 60 persons were selected, among them Sergei Korolev.

The first lessons were held in the canteen of the Rabfak, and the lecturer's voice could sometimes not be heard for the rattle of plates. The canteen was a dreary place, dimly lit, and it was difficult to see in the yellow light of the lamps what was scrawled in chalk on the tiny blackboard. Later they were 'asked' to leave the canteen, and began to meet in the workshop. Lectures were taken down on the machine tools, and many a notebook had a dark oil stains on it. But they put up with it, dreaming of spring and the vast park lawns where they would be able to lie on the grass and listen to the lectures. And no doubt they would have survived until the warm, if Kharkov had not cut off funds for the course without explanation. The course broke up in April. The more active and enthusiastic of the lads were not prepared to give in and decided to forget about the money and to rely completely on their own initiative. The course they decided on was as follows: theory was all very well, but they must build gliders and learn to fly them themselves.

The projects by which the gliders were to be built had by that time already been approved by the top authorities. In March the winners of the Ukrainian competition of projects for record and training gliders had been named in Kharkov. First prize in the record glider group and the sum of one thousand roubles to build a glider was awarded to Tomashevich, Zheleznikov, and Savinsky of Kiev for their KPIR-4 project, and in the training glider section Karatsuba and Ambold were declared the winners with their KPIR-3.

The Institute was exaltant—complete victory! Everyone was itching to get to work: now we'll build and build!

Materials were obtained by hook and by crook. Messengers rushed from the Poly to the pilots' quarters and the pilots of the fighter squadron, to the Air Repair Depot No.

6—there were fine fellows there who had promised some planks, and they had alder plywood, too. In short, work was in full swing.

It was decided that the Institute should have four gliders by the summer: first the KPIR-1, damaged in autumn in Koktebel, was to be overhauled; then the KPIR-1-A, an improved version of the old glider, was to be built, and the KPIR-4 record glider, and finally, the KPIR-3 trainer. This was reported at a city glider conference held in spring. It was also disclosed there that the fighter squadron intended building a rally glider from the plans of Gribovsky, a military pilot, 'Air Repair Depot No. 6' an aeromotorcycle, the staff of the South-Western Railway a training glider, and the boys of Labour School No. 43 another experimental glider. Kiev began to sprout wings. The reports at the conference made one's head whirl.

Under stairs of the Poly's main entrance, life began to seethe; saws buzzed and the workbenches foamed with shavings: building was in full swing. All the work was directed by graduates, Zheleznikov, Savinsky, Karatsuba, Tomashevich, and, of course, Yakovchuk. Konstantin Yakovchuk, thickset, strong, with prominent cheek-bones and dark, finely curled locks, was very popular in Kiev. He had begun flying long ago, had been a pilot in the Civil War, shot down, and reported killed in *Aviation and Aeronautics.* After the plaster was removed from his broken leg he had started flying again, and returned to Kiev with the Order of the Red Banner. On July 9, 1923 Yakovchuk made a bold demonstration flight from the tiny open space of Proletarsky Park. Later he had worked as a test pilot at Air Repair Depot No. 6, and afterwards had enrolled at the Poly and taken up gliding. Yakovchuk was the idol of the students, and Rector Bobrov used to shake hands with him. In the workshop Yakovchuk brought his authority to bear on the students, shouted at them, made them do things over again, hustled them and spurred them on; but nobody felt any

ill will, because he himself worked harder than any one else and was very quick.

Sergei Korolev, being a newcomer to the workshop, was allotted a job of minor importance, and his position pained him. Once he tried to start an argument and offer his own solutions, but he was immediately rebuffed as a greenhorn. Sergei quickly realized that he didn't stand a chance of flying a record glider; too many wanted to, and he was sure to be pushed aside by the 'old hands'. All his hopes were pinned on the KPIR-3 trainer. The unwritten rule was that whoever built a glider flew it. Sly Korolev began slowly edging his way closer and closer to the corner where the skeleton of the future KPIR-3 gleamed.

Sergei was working in Skryzhinsky's squad. Their job was to assemble KPIR-3 and KPIR-1-A, but sometimes they also went to the help of the other groups. Everyone was in a hurry: tests were to start in summer.

The winter was wet and foul. Sergei's shoes wore out: he tried to mend them with wire, but they fell to pieces. As the new year set in he rented a bed on Bo[illegible]outovskaya St. which was quite near the Institute if you took the road past the St. Theodore's Church and across the Kiev refuse dump. Money became quite short. He had only enough to pay for the bed and a bit of food. One thing saved him—Sunday dinner at his grandmother's on Nekrasovskaya St. Old Anna, the cook, had refused to leave his grandmother.

She knew the secret of a wonderful red Ukrainian borsch that made your mouth water. And the pies! Grandma grumbled mildly, scolding at the market, and recalling the plenty of prewar Nezhin, Sergei relaxed from the warmth and satiety and felt sleepy. But his grandmother had no money to buy him shoes, and even if she had, he would not have taken it. So he had to take on a job humping sugar. The work was hard, and his back hurt intolerably afterward, but the pay was all right. It was with money earned as a

porter that the future Lenin Prize winner bought his first pair of new shoes.

What with the newspaper office in the morning, then the workshop, and studies in the evening, his days rolled on toward spring. He and Puzanov walked over to the airmen in their quarters less often now, not more than twice a week, although the airmen were always glad to see them. Once Pavlov spotted them walking across the field behind the railway and started chasing them with his plane, flying so low that it seemed you could jump up and grab hold of its wheels. Savchuk called him reckless, but Pavlov took no notice, only laughing and winking at Sergei and Mikhail. He was already thinking of building a baby plane and often talked about it, sketching various units and parts on paper. Sergei would have very much liked to take part in building it, but tests were ahead, and then he thought it wouldn't be right to desert the lads in the workshop. He consistently tried everything to persuade Pavlov to wait until the summer when the gliders would be ready, and then to 'press on with the plane'.

Once Pavlov introduced Korolev to a little lively, dark-haired man, Vladislav Gribovsky, a military pilot who too was building a record glider, but was already absorbed in future projects. Many of them were realized, incidentally: during the seventeen years of his work as a constructor between 1925 and 1942 V. K. Gribovsky built 17 gliders and 20 planes.

'Have you heard about Germany?' Gribovsky asked them.

'No. What about Germany?' Pavlov raised a handsome brow.

'Haven't you really! The Rhön-Rositten Society has invited our glider people to take part in a meeting in Germany!'

For a second a mad idea surged through Sergei's mind: 'What if he were to go? But what would he do in Germany at an international rally if he still hadn't even once sat

in a trainer? He would do well to get as far as Koktebel, let alone Germany.'

'It looks as if Yakovchuk is all set to go,' Gribovsky continued.

'Yakovchuk's far ahead of me,' Sergei thought. He hadn't himself noticed that for some time now he had been copying Yakovchuk down to the minutest detail, had bought himself a grey polka-dot shirt like Yakovchuk's and rolled the sleeves up in the same way. He had even adopted his manner of speaking, precise, rather harsh, and categorical.

In spite of the fact that the German invitation had been received and Yakovchuk pushed the lads in the workshop even more, work on the gliders slowed down: the Poly tests were looming ahead, and the glider enthusiasts were buried in their books. On several occasions only Venyarsky, an old cabinet maker, was working in the workshop below the stairs.

Korolev couldn't refrain from going to Odessa for May Day to see Lyalya and his mother. Lyalya told him that Max was being transferred to Kharkov, and that she, too, would be moving with her father if her transfer from the Odessa Chemical and Pharmaceutical Institute to the Kharkov Medical Institute could be arranged.

It was fine and warm in Odessa, and he had no wish to leave, especially when he thought about the tests. The few days passed as in a dream, and there was the train again, new leaves of acacias by the railway stations, and market women selling waxy fried chicken.

After returning to Kiev Korolev spent whole days with Puzanov in the airmen's rooms preparing for the tests. Before the New Year he had passed in chemistry, Ukrainian and higher mathematics, part I. Now he had to do the physics lab work, architecture and building, mathematics, part II, and engineering mechanics. All four were most afraid of mechanics. The lectures in mechanics were read by the head of the chair, Staierman, a short, awkward man

with a bristling moustache, who spoke rapidly with a slight Jewish accent, and danced around the blackboard. Once, during the winter Puzanov had told Korolev in the tramcar: 'Staierman's is the first lecture. He's going to dance something for us again at the blackboard.'

Sergei prodded Puzanov with his elbow and rolled his eyes wildly. There, standing next to him, was Staierman.

After that there was hardly a lecture when the vindictive mechanician did not call them to the blackboard. 'We'll be dancing for a long time because of your "dances",' Korolev gloomily cracked.

You can imagine his astonishment when Staierman passed him without asking anything. The same thing happened at the mathematics test. The seminars were taken by Leo Strum, a man of many interests and enthusiasm and of an inquiring turn of mind. Apart from mathematics he had a passion for atomic physics and had even written papers on the structure of the nucleus. Strum had been impressed by the answers of this youthful dark-eyed student and remembering them gave him a pass right away, pedantically noting in his report after the examination: 'Knowledge was mainly controlled directly during the studies themselves, regularly. Some students, the most active, received a pass without testing.'

Marks were not assigned then, so that it is difficult to say now what subjects Korolev was especially proficient in, but his fellow-students recollect that he did well in all subjects, pushing, often volunteered to go to the blackboard, raised his hand on time without number and generally was quite unlike the Korolev of Odessa. It can be explained. Or rather an explanation can be suggested. His childhood without children of his age and his piecemeal education had left him without experience of boys' society, and at the Building School he had been, if not exactly pushed about, still put in the shade by the others. Being

proud and vain, and unaccustomed to giving way, he withdrew into himself and only slowly gained the position in his class that he deserved. And he didn't wholly complete the process in Odessa; his studies there finished, but the process of self-assertion continued at Kiev Poly. And there was an additional incentive for him to try to prove that he was not only no worse than the others, but even better, and that was his need to win the respect he desired of the glider club.

Once tests were over, Korolev again spent all of his leisure in the workshop. Time was running out, and everybody was nervous, especially Yakovchuk, who was afraid of being late for the international rally. The Soviet glider team had already been chosen. Five gliders were to be sent to Germany: Mosaviakhim AVF-21 designed by S. Ilyushin, B. Kudrin, and N. Leontiev; V. Vakhmistrov and M. Tikhonravov's Zmei Gorynych; I. Artamonov's Krasnaya Presnya; A. Chesalov's Transcaucasian, and Tomashevich and Zheleznyakov's KPIR. They were to be flown by our best glider pilots Artseulov, Zernov, Kudrin, Sergeev, Jungmeister, and Yakovchuk.

Korolev had heard these names before, but now, when they were being mentioned together, he again caught himself thinking he was ready to fly to Germany, just to see them all together, meet them, talk to them, get advice from them. It was known that the team would come to Koktebel straight from Germany for the Third All-Union Glider Rally and Sergei's hopes of getting a ticket to the Crimea rose again.

In the summer construction of the gliders went on under an awning in the courtyard. Sergei worked with great enthusiasm; he wanted to start flying as soon as possible. Many years later S. I. Karatsuba wrote about the Korolev of those days: 'He was one of those who needed no additional explanations or reminders. He had only to know "what was to be done"; the "how" was his own business. And he never

did anything rashly. I don't remember a single instance of his work having to be done over again.'

On one occasion, when he and Korolev were inspecting the assembling of KPIR-3, Sergei led conversation around to Koktebel. Karatsuba hesitated and promised nothing, for he couldn't promise anything. He belonged to the Poly's glider élite, but he couldn't make Sergei a member of the team 'on his own'. 'Speak to Yakovchuk,' was his advice.

Sergei began to think up some sly move to bring the conversation with Yakovchuk, but could think of nothing; angry with himself, he sought out Yakovchuk and began without any beating about the bush: 'Comrade Yakovchuk, I'd very much like to go to Feodosia. Take me along.'

Yakovchuk chewed on the end of his cigarette and looked at him, screwing up his eyes: 'You? Do you deserve it?'

How to reply? Any answer would sound silly. Korolev stood silent.

'Zheleznikov, now, he deserves it. Tomashevich's not as brawny as you, but he's been at it all the year without respite.'

'And haven't I been stuck at it?' Korolev asked angrily.

'I haven't seen much of you,' Yakovchuk answered curtly, taking the cigarette out of his mouth with a jerk.

The blood rushed to Sergei's face. He turned sharply about and walked away quickly with his head between his shoulders and his fists thrust deep into his trouser pockets, muttering: 'All right. You'll see. You'll see.' It wasn't clear whether it was meant as a consolation to himself, a threat to Yakovchuk, or a promise.

In the autumn Balanin and Sergei's mother moved to Moscow. She wrote Sergei that they were living on Krasnoselskaya Street, near Sokolniki Park, the flat was rather shabby, but a larger one nearer the city centre has been promised. There was not a word in it about his coming to

the capital, too, but some fine details, some hints between the lines, gave Sergei the impression that his mother missed him and wanted him to come. But perhaps there were no such hints at all, just that he wished so much to see them and so did.

Although he had studied well and had no debts, no 'arrears' or other student burdens, he hadn't taken to Kiev, as Puzanov put it. It was strange. Odessa, even without Lyalya, without his mother, with people he didn't know living in their old flat on Platonov Pier, still remained for him a part of himself, while Kiev was a stranger. He didn't know why, but he wasn't happy there. Or rather, he knew certainly, and felt it.

Kiev's aviation traditions and the progress of gliding there were the things he had pinned his hopes on while in Odessa, but having come to Kiev he saw them in a different light. The small, tightly-knit circle of incipient pilots and constructors had not welcomed him with opened arms and cries of joy. They were older than he, not much, but still several years older, and that means a lot in youth; they were more experienced, they had known each other for many years, and it was impossible for a young newcomer, a freshman, to break into their circle. In a few years they might have recognized his talent and trusted his experience, but even then they would remain maestros to him. Korolev felt that he had taken the wrong tack from his very first day at the Poly, that he shouldn't have walked around like a lost, timid provincial, that he should, on the contrary, have been demanding, thrusting and cheeky as the devil! He shouldn't have been content with crumbs, but should have taken a bite without fear of not being able to chew. He'd have managed somehow. He saw no attractive future ahead and he could not see how this situation was to be changed. His studies, he reassured himself, were not going badly, and that was the main thing, but he was not satisfied. Study alone was not enough. He wanted a free,

new, interesting occupation in which he could use his head, calculate, invent, experiment, build, and fly—flying was a must. He wanted an affair of his own, and the whole trouble was that he had had one in Odessa, but in Kiev he didn't.

And there was something else, whether he thought about it or not; probably, he did think of it. It was simply that it was difficult to live in Kiev. His mother sent him money, but the remittances were very small. He did not ask for help from Uncle Yuri or from his young second cousin Alexander Lazarenko who had only recently graduated from the Poly. He didn't even want to think of it. Grandma herself needed help, and he was grateful to her for Sunday dinners. In a nutshell, he was hard up for cash. He had to count every rouble, to figure what he should buy and what he shouldn't, what he could eat or what he had better go without, whether he should take a tram, or whether he should walk. His clothes were neat, but very shabby; but in those days nobody paid any attention to that, and his shabbiness didn't bother him. What irritated him was something different; some convolution in his brain was always occupied with what, from his point of view, was an idle and humiliating business—where to find means of subsistence. One day he would join a gang of dockers at the wharf; another day, remembering the fun on the roof of the Odessa Medical Institute, he would take a job as a tiler; and once he even landed up as a film extra.

The film *Tripolye Tragedy*, that director Anoshchenko and cameraman Lehmke were shooting near Kiev, was based on an actual happening during the Civil War. During Denikin's offensive in the Ukraine in 1919 various gangs of bandits roamed the country. Members of the Kiev Young Communist League had fought heroically against one of these bands, led by one Daniel Terpil known throughout the Ukraine as the Green Ataman, but were surrounded and driven to the precipitous banks of the Dnieper. There

they had been shot at point-blank range and pushed over the cliff.

As work on the picture progressed young extras were needed to help film this difficult and dangerous episode. Notices were posted in the halls of Kiev institutes inviting students to take part, and Korolev decided to take the job.

In Tripolye all the newly-fledged actors were issued great-coats, and puttees, and were given rifles and lengthy instructions on where they had to run and how to 'shoot'. As a bayonet charge was being shot Sergei got so carried away that he struck a 'bandit' full force with the butt of his rifle. The 'bandit' protested to Anoshchenko that Korolev fought in earnest.

His next bit, with other lads, was to simulate corpses floating down the river. The next day he made a name for himself in the group by diving from the steep bank into the Dnieper for the main characters of the film. 'Greg scolded me for diving off the ships,' he thought mischievously, 'but he couldn't possibly have known that I'd be earning kopecks that way.'

It was gay and interesting with the film people, but Sergei could not stay on location in Tripolye long. After the sharp exchange of words with Yakovchuk he somehow swallowed his pride and returned to the workshop. In fact, Yakovchuk had been right, he hadn't been working long. All right, if he couldn't go to the Crimea he could try gliding here in Kiev. The main thing was not even the flying; the main thing was that he was learning how to build gliders, that he now knew where to begin and where to finish, how to choose material and how to work it, and that he had learned, as old Venyarsky said, to 'understand wood'.

There was very little work left to be done on the KPIR-3 but, as always happens, on the very last days things began to break and tear and get punctured, things that had fitted exactly yesterday wouldn't go into place today, things that had been tight became loose, and things that had moved

easily stuck. Korolev was still ignorant of this devilish law by which all troubles crop up at the most inconvenient moment.

They worked till late at night and were so tired that Sergei hadn't the strength to go home to Bogoutovskaya St. and bedded down without undressing in a box stuffed with fragrant shavings.

The long-awaited day came at last. All the gliders were taken to the lawn in front of the Institute. Delone, Sineutsky, Staierman, and Bobrov, the rector, came to inspect them. It was both a parade and an examination. Delone was already quite old and grey; he wore a cap pulled right down to his brows, but under the peak his eyes gleamed with boyish mischief. He questioned Yakovchuk about the gliders, demanded accurate figures, and then checked them, looking into his notebook. Sineutsky, in a crumpled linen tunic, circled around the gliders and felt everything carefully as if he didn't believe his eyes. Hopping gaily beside him, like a grass-hopper, was Staierman. Bobrov didn't inspect anything, asked nothing, but just went around stroking his pointed beard and smiling at everyone. He was apparently highly pleased and didn't think it necessary to conceal it.

The next day the KPIR-4 and KPIR-1-A gliders had to be disassembled and packed into crates to be sent off immediately to Rhön in Germany. But it was still early to send the KPIR-3 trainer to the Crimea. So it was decided to make some flights in Kiev. The lads looked at it with such eager eyes that nobody had the heart to stop them rewarding themselves for their work by having a go at some easy flights.

The ground used for glider training today is occupied by the Bolshevik Factory metro station and the printing plant of the newspaper *Radyanska Ukraina*. But in those years it was a large stretch of waste ground with heaps of rubbish and refuse scattered about it. Still there was room enough for taking-off. It is on that waste land that Sergei Korolev

the glider-pilot was born. Strictly speaking they didn't fly, but made take-offs. The glider merely rose from the ground, flew twenty yards or so, and landed on its belly. But still those few short seconds enabled the novices to get the feel that they were flying and to guess, rather than to understand, the response of the light-winged contraption to their first timid and inaccurate movements of the joystick. And as it had to happen, Korolev, of all people, had a stroke of bad luck on one of those first flights!

Everything had gone as usual: the lads held the tail, tightened catapult, and let the glider go. Sergei unhurriedly pulled the stick toward him just a little, and the glider nosed up slightly; but he knew that he must not overdo it for that would make him lose speed, slip, and all too easily to crash. After zooming gently he flew to the edge of the field for the landing. Perhaps the wind freshened, or perhaps he was handling the stick with greater skill than usual, but he had never before had such a feeling of ease and freedom in the air! Never before had he had such a feeling of flight. So far he had simply been sitting in a flying glider, but now he was flying and the glider was simply helping him. All the feeling of tightness and strain in his body was gone, dissolved in this smooth motion. He had never felt so good. And at that happy moment he caught sight of that damned pipe.

Korolev had not noticed that he had reached the very end of the training grounds. There a rusty water-pipe was sticking out of a heap of rubble, and he was heading straight for it. The lack of height and dwindling speed of the glider made any manoeuvre impossible. He was slowly and smoothly, like a paper dart, coming down onto the pipe. There was a dry crack—'like Anna, the cook, splitting sticks for the samovar in Nezhin'—a crash, and Sergei was thrown out of the glider and probably lost consciousness for a second.

Little damage was done to the glider, and Sergei, too, got off quite lightly. He could have broken an arm, but the

impact came exactly on his wrist and the watch, Greg's last present before he had left for Kiev, was smashed into bits. He felt a heavy pain in his side, especially when he drew a deep breath. Ribs, probably, but hardly a fracture. More likely a crack. That day he had great difficulty in reaching Bogoutovskaya St. He stayed in bed for two days and then went to the Institute; he was anxious to hear what news there was from Germany, about how their team was doing.

News there was and very pleasant news, too. On the Wasserkuppe Mountain the Soviet lads had come ahead of Martins, Schultz, Papenmeyer, Nehring, and other ace glider pilots. The three Soviet pilots received silver cups, and the team as a whole received the prize for general technical achievements in designing and flying gliders in the form of a superb Ludolf compass. Newspapers wrote about them, and magazines carried their photographs. 'Only the Russian pilots had given zest to the meeting,' the *Frankfurter Zeitung* wrote.

Every one at Kiev Poly, it goes without saying, was jubilant. The news made Sergei even more eager to go to the Crimea, and he watched with growing anguish the KPIR-3 (repaired after the crash) being packed into a crate and the lucky ones with travel warrants to Feodosia running about the Institute. And then there was the trouble with Pavlov. He had flown under a bridge and was now being posted away from the squadron to some flying school to work as an instructor. Savchuk alternated between visits to the commanding officer to plead for Pavlov and cursing the latter in the crudest form, calling him reckless fool. He pleaded in vain; Pavlov had to go. Sergei came to see him off, not knowing that he would quite soon again be meeting this handsome lad with the external wide scarf round his neck. His thoughts then were that they would all be going to miss Pavlov very much, and he, Sergei, most of all since he had hoped so to start work on the light aeroplane in September.

And here it was September and they were sitting in the big physics lecture room again, all on the same bench once more, but now not the four of them, but only three. Lectures began, and in September Korolev was examined in technical drawing by Schultz and passed the test brilliantly. In January 1926 he passed his last test, in higher mathematics, ahead of schedule. He was studying hard and well, spending long hours over his notes; but everything he did was sluggish, without the old keenness, and his interest in science was rather abstract. Only the yarns of the lads who came back from Koktebel in October cheered him up a little.

The Third All-Union Rally had been a real triumph for the Kiev team. The technical commission had rejected the KPIR-1-A, but Yakovchuk had taken it up at his own risk and set a Soviet record for the duration of a flight: 9 hours 35 minutes and 15 seconds. He flew until night fell and they had to light fires so he could land. And Yumashev, also from Kiev, had broken all records for distance—4.8 kilometres. The report was: '... the gliders of the Kiev Polytechnical Institute made the largest number of record flights. For considered design, clean finish, and ease of assembly they have no equal among Soviet gliders.' It was a eulogy, not an article. The only trouble was that the victors came back without the gliders; during a storm the lads had rushed to save the gliders of the German guests at the rally, and had failed to save their own. So now there was nothing to fly.

Korolev was annoyed by the endless flood of exultant reminiscences of the victories in Germany and the Crimea.

'What's next?' he asked. 'Are we going to be talking about our victories all our lives? We must call the circle together and build new gliders.'

Yakovchuk, now gay and carefree, brushed him aside. The circle disintegrated, as was to be expected; it had been held together by few 'giants', and they had all graduated. They succeeded in building quite good gliders, but had

failed to bring on replacements for themselves. Now they had gone away and only the executors of their designs were left, soldiers without officers.

A man learns from life to his dying day. No one can say today how long Korolev remembered that sad episode of the Kiev glider circle, but we know for certain that he was very much preoccupied in the last years of his life with the problem of succession and the training of scientific and engineering replacements; at important meetings his many deputies and leading engineers would notice him throwing appraising glances at them as if wondering: 'Which of you is going to take my place?'

To complete Sergei's troubles, Puzanov decided to get married. The old quartet of friends could not withstand this new shock, coming after Pavlov's departure, and they met more and more seldom in the pilots' quarters. Savchuk was busy arranging a transfer for himself, having decided to go back to hydroplanes. Puzanov, now a family man, had shouldered many heavy, in some respects sweet, burdens, and for the first time Sergei suddenly felt that the nine years' difference between them was too much, that Mikhail was indeed a grown man with a man's joys and cares, while he, Sergei, was still, after all, a boy.

He began to feel quite lonely, though there were the letters from Lyalya and his mother wrote frequently from Moscow. In one of her letters she said she had heard that there was an aviation course at the Bauman Higher Technical School, but she wasn't quite sure and would have to find out more exactly. 'It's hardly likely that there isn't,' thought Sergei, 'since Zhukovsky himself lectured there, and Tupolev graduated from that school.'

So he got down to his books and notes again. Years later, remembering those years, he used to say: 'I rapped my forehead—study, you fool; you won't do anything in life without

science. And I nibbled away at science.' Again there were lectures and lab work, sometimes lasting until midnight. Once more there were the neat white lines and amazingly straight blackboard drawings of Schultz, the pedantic hunchback who lectured in applied mechanics, again there were laughter and anecdotes of Skoromokhov, the reader in electrical engineering, and the wonderful lectures on thermodynamics of Usenko, who mixed up Russian and Ukrainian words and could begin with the Carnot cycle and end up with the rare butterflies of the Amazon. Of all the lab work Korolev preferred the practical lessons in electrical engineering under Ogievsky, an old radio engineer. It was said that he had spoken with Lenin. Teaching at the Poly was not his only job; he was also building the first broadcasting station in the Ukraine. He was a calm, authoritative man, who never picked on his students and never tried to win their approval by funny jokes, but who persistently demanded of them all that he was entitled to demand. For Korolev he was the ideal man of business: 'That's what a real engineer should be like.'

Imperceptibly the end of term crept nearer. In June 1926 Korolev passed ten tests, completing curriculum for the second year. Then they saw Savchuk off, who was returning to the Black Sea.

Before he left Savchuk gave Puzanov a drawing board and three volumes of the Hütte engineering handbook as a parting gift. To Sergei he said: 'I 'm not giving you anything. Surplus belongings will only be a drag on you. Go to Moscow, Sergei; I can see it's time for you to go.'

Sergei turned to Puzanov who nodded sadly: 'It's time.'

And again there was a tightening in his throat, and his heart ached, as it had on the beach in Arcadia, but he felt, or rather he knew, that his friends were right, that it really was time.

'To the Rector of the KPI
From Stud. Korolev, S. P., Mech. Fac.

Declaration

By a resolution of the Admissions Commission of the Moscow Higher Technical School I have been admitted to it as a student, and this is to inform you of the fact.

S. Korolev

27.9.26'

From that time on Korolev never again lived in the Ukraine. He visited Odessa and Kharkov, made several trips to the Donbas, went to the Crimea regularly for many years, but never again did he live there. After Gagarin's flight he once said he wanted very much to go to Odessa again. He knew he could not return to his youth. It was simply a yearning for that corner of the land. He wanted to sit on the rocks of Arcadia, to stroll along Pushkinskaya St. early in the morning when it is still sleepy and wet in the long rosy shadows of the plane trees, and to see the sea suddenly open up beyond the poet's glistening bronze head.

End of Part One

PART TWO

Wings

CHAPTER 12

The Moscow orphanage 'for shameful infants born unlawfully of women and maidens' was founded in the reign of Catherine II. To prepare 'the shameful' for life they have to be given a trade of some sort, and for that reason the orphanage was given the status of a trade school on July 1, 1830. Fourteen years later a new charter was granted by which the inmates were not to be trained for simple trades, but were to become craftsmen with considerable knowledge of theory. In the seventies the school was reorganized in every aspect as a higher educational establishment. The acute need for engineers raised the prestige of the Moscow Technical School, and its diploma began to rival that of a University in standing. Its teaching methods and syllabuses were awarded medals at world exhibitions, and in recognition of its outstanding achievements the low, thick-walled building on the Yauza River was granted the high-sounding title of the Imperial Technical School.

The building itself, incidentally, was historic. In the middle of the eighteenth century it had been part of the enormous palace of A. Bestuzhev-Ryumin. Afterwards it had belonged to A. Bezborodko, who made a present of it to Emperor Paul I. The 'Suburban Palace', as it was called, was built and altered by the famous architects D. Quarenghi, M. Kazakov, and D. Gilliardi and was considered one of the best in Moscow. It was not without reason that the King of Poland, Stanislaw Poniatowski, wrote that in all Europe there is none like it for luxury and decoration.

But, however thick the walls of this house were, they could not shelter its inmates from the mutinous winds of the twentieth century. Here, in 1905, a crowd seethed and boiled with anger, and vows of wrath sounded in the speeches over the body of a handsome man, still quite young, with a pointed ginger beard. They had brought him here, to the draughtsmen's hall, already dead, with his head

smashed in, and the feet of the hundreds of people who came smeared the drops of his blood on the tiles, grey with age. This was where his funeral began, a political demonstration thousands strong, never before known in Czar Nicolas empire, a procession terrible in its undisguised fury. His name—Nikolai Bauman—rang across Russia like a tocsin summoning people to battle. And the day came when the high-sounding title 'Imperial' became meaningless and ridiculous and was torn off like the badge from a cap. A new history began for the School, now the Moscow Higher Technical School.

Moscow Tech experienced all the hardships of the first years of the Revolution. There were days when it seemed that life was totally extinct in the old building; but energy and faith rekindled the glowing coals, the lecture halls and laboratories and workshops warmed up and came to life again. Month by month, and year by year a new life began gradually to take shape.

The social stratification was no different of course here than at Kiev Poly. Most of the professors held aloof and were sometimes even hostile. Political convictions were mingled with balderdash: Prof. Kukolevsky refused to recognize the Soviet Government, regarding the Bolsheviks simply as vandals; Prof. Mertsalov demonstratively avoided travelling by tram. More than one day was needed to reconcile thirty-five-year-old men in black greatcoats with a blue trim and tabs on which gleamed hammers, and with the letters ITU* in gold braid, and a strange emblem, pelican, on their shoulder straps, to the former Rabfak evening students, grim fellows in faded Russian blouses and greasy caps, some of whom had only learned to read a few months before. By 1926 the School resembled a hot kettle in which, below a film of external well-being and adminis-

* From the abbreviations of the Russian for Engineering Technical School.—*Tr.*

trative efficiency, the class strife that had seethed there yesterday had not yet cooled.

By his age, his convictions, and his origins, it was utterly impossible for Sergei Korolev to join the camp of the former 'Imperial' students. But his questionnaire, in which 'middle class' was written under the item 'Former Social Status of Parents', was tantamount in those days to some social deficiency. In 1927 13 per cent of the graduates of Moscow Tech were the children of workers and only 4.2 per cent were members of the Communist Party or of the Young Communist League (Komsomol). That was the year when proletarization of the School began. Even its newspaper was called *Proletarians at Study*. Korolev was one of those who, by their mere presence, could not support this campaign. Although he had been working from the age of sixteen, he had come to the Tech neither 'from the lathe' nor 'from the plough'. It's hard to believe now, but Korolev could not then be considered a 100 per cent 'red'. He was among the 'pinks'. The attitude toward those like him was not hostile, but was rather cagey. They were looked on with suspicion, were not readily accepted into the Komsomol or into the trade union. That is perhaps why Korolev's astounding young energy left no trace on the social and political life of the Tech. Its enormous charge was directed entirely toward the goal to which he had already dedicated his whole life, to aviation.

Moscow Tech's aeronautical traditions had already won a world reputation. N. E. Zhukovsky had come there in 1872. One of the world's first wind tunnels had been built there in 1902, and eight years later an aerodynamics laboratory had been set up. There, in Zhukovsky's nest, his 'fledgelings', the teachers of today's teachers, had grown their feathers. Fifteen years before Korolev's first flight, Andrei Tupolev, a second-year student, had taken off in a glider from a sparse orchard next door to the School.

Sergei was admitted to Moscow Tech as a third-year stu-

dent just as courses in special disciplines had been begun. After the 'abstract' courses of Kiev Poly—mathematics, physics, chemistry, and strength of materials—the mere names of those courses were music in his ears: 'Flight Dynamics', 'Calculation of Aircraft Aerodynamics', 'Aeroplane Construction'.

At last he saw the people he had heard so much about: A. N. Tupolev, unexpectedly young, read his first introductory lecture. Sergei was enchanted by the simplicity and spontaneity of V. P. Vetchinkin, who had been Russia's first engineer with a degree in aircraft construction. Vetchinkin had developed the theory of the screw propeller originally advanced by Zhukovsky, and was famous as an expert on calculating the strength of blades. He designed aeroplane and helicopter propellers and enormous wind-tunnel fans. And here was this famed 38-year-old professor talking to them like colleagues. In his lectures he might repeat himself or 'skip' some chapter, but his lectures were always unusually lively and interesting; he himself provoked discussion and gladly answered questions. One day Konstantin Fedyaevsky, who studied in the same group as Korolev, climbed up on a desk and began throwing paper darts. Vetchinkin came into the room just then, and Fedyaevsky jumped down, blushing red as a lobster. 'No, no! Continue,' Vetchinkin said sternly. 'Let's see what makes them fly.'

Lectures were not compulsory, but all the third-year students went to A. M. Cheremukhin's lectures. Cheremukhin had graduated from a flying school before the Revolution, had been an instructor in Sevastopol, and had then worked in the aerodynamics laboratory of the Central Aerohydrodynamic Institute from its very foundation, building unique wind tunnels. Zhukovsky had sensed in him a man whose varied talents would always be devoted to aviation. Cheremukhin's subject was the calculation of aircraft strength. The students realized that it was the main one

for them, for they all, to a man, dreamed of independent work as constructors.

B. N. Yuriev had given up a career in the Moscow Cadet Corps for aviation. He was the first in the world to give a theoretical substantiation of helicopter flight. During the war he had been a prisoner-of-war in Germany. As soon as he returned to Russia he went to Zhukovsky. Yuriev was married to Zhukovsky's daughter Elena, and was regarded as the old man's favourite pupil. He was dean as it were of the aeromechanical department, and lectured on experimental aerodynamics. He was in a state of continuous war with many of the members of the board of studies who were deeply convinced that a man who had never designed a boiler could not receive the diploma of the Moscow Technical School.

'Try to understand, this is a quite new field of engineering that requires a fundamentally new approach to the training of engineers,' he used to say to the other professors. 'Try to understand. Aviation is a world in itself and not just some discipline for its own sake. If you study like that you'll end up in the soap,' he used to say to the students.

Korolev's teachers were G. N. Musinyants, K. A. Ushakov, B. S. Stechkin, and N. V. Fomin, the fathers of the Central Aerohydrodynamic Institute, and the leading Soviet aviation specialists of the day. None of them could draw a line between their work at the Institute and teaching at the Moscow Tech. The training of young engineers was not some abstract problem of national importance for them but, if you want, a strictly personal affair on which hung the work of their departments and laboratories and the future of their plans and programmes.

The method of training engineers using research undertakings considered in the Fifties as a discovery of the Moscow Institute of Technical Physics had existed 30 years before in the Aeromechanical Faculty of Moscow Tech. Nearly all the third-year students worked in the Institu-

te's laboratories. Whether to work in the Institute or in the Tech was considered irrelevant, for they were neighbours. From the first year almost everyone was designing and constructing something: Gennady Bertosh a glider, Savva Krichevsky a light aeroplane, Alexander Silman a scooter. In addition they were all working somewhere as draughtsmen or mechanics, and sometimes as constructors on engineering jobs. This work was no less important than their studies, and the lecturers knew that when they made attendance voluntary, realizing that their students were not idle youths but adults, earnest, busy people making a difficult living.

The work united them more than their studies; years later, remembering their student years, they recalled the names of workmates more frequently and more accurately than the names of fellow students. Sergei Korolev had no friend in his group like Val Bozhko or George Kalashnikov in Odessa, or Mikhail Puzanov in Kiev. But there were other friends that he owed not to lectures and seminars, but to work.

Sergei took things and found his place extremely quickly, and realized that one aspect of his new position was very important to him. The student body in Moscow was much more democratic than in Kiev. Of course, there were already groups and cliques among the third-year students, but none of them dominated the others. There was no hierarchic pyramid as in Kiev, the authorities exerted no pressure, the scope for work gave greater freedom, that creative freedom he had dreamed so much about. Everyone had his job, and it remained for him to make his choice.

In the very first week Korolev attended the AKNEZH*. Later he sought out Vladimir Titov, a student in his faculty

* AKNEZH was an acronym from the Russian title of the Zhukovsky Academic Circle, the prototype of present-day Soviet student scientific societies.

and director of the amateur glider school, and immediately enrolled in the flying section. Now, early every Sunday morning he rushed to the Paveletsky Station and took a train to the glider station at Gorki Leninskie.

In November 1926 a joint session of the boards of Aviakhim and the Society to Aid Defence decided to merge the two societies in one organization, Osoaviakhim. The first congress of Osoaviakhim was to be held January 1927, and the students decided to have their glider station ready for this date, or bust. They renovated the sheds, loudly calling them hangars, and repaired their gliders. The lads from the School's first enrolment, the 'old hands' who had joined in the previous January, used their free minutes to do some gliding. Sergei was envious of them, but pulled with a will on the catapult, for he knew his turn was coming. In short, he started working at full throttle right from the first weeks of his time in Moscow and barely had the strength in the evening to get home to his mother on Alexandrovskaya Street, where she had moved soon after his arrival.

On December 9, 1926 *Komsomolskaya Pravda* announced that, with the support of the Moscow Committee of the Komsomol, it was organizing a three-day trip to Leningrad. For 18 roubles participants would get a bed and three meals per day. The programme included a sight-seeing trip to historical places and an excursion to the Volkhov construction site where a hydroelectric power station was being built.

The Bauman District Committee received 75 tickets, and Sergei Korolev undertook to distribute them. Not many were anxious to go. Or, rather there was no lack of willing students, but few who had the 18 roubles.

It had planned to send 600, but hardly half that number booked for the trip. On December 23rd, a cold, foggy mor-

ning, the tourists assembled on the square before the Leningrad Station (now known as Komsomolskaya Square). The station buzzed with young voices. Everyone was excited, bustling about, laughing and looking all the time for some one. The train was late, and the commotion increased. A representative of the People's Commissariat for Railways suddenly began talking vaguely about heated goods wagons. The noise and disturbance increased. There were shouts of 'Give us cars'. Just as it seemed the whole thing would be abandoned, there came an unexpected announcement of 270 places at a reduced rate. Finally out of gloom into which the rails ran shining dimly, a powerful Pacific type locomotive whistled jauntily, and puffing and clanking, slowly drew the long-awaited train, No. 8-A, into the platform. The tourists crowded gaily in the carriages, and the train pulled out.

No one slept that night, of course. They sang, drowning the rattle of the wheels, and coughed from the blue smoke of cheap cigarettes, and roared with laughter at various yarns, both funny and not so funny.

As a group leader, Sergei had been running about all day and worrying, and now he leaned wearily against the side of the compartment occasionally glancing out the window into the impenetrable empty darkness. That concealed the movement of the train. A quite young, blue-eyed lad sat opposite him. Sergei remembered having seen him at the School, and at the AKNEZH. They started talking.

Pyotr Flyorov, although only a first-year student, was a lad of experience. When Sergei learned that he had already flown in 1922 he began to respect him, and in order not to lose face, started talking about his flights on the hydroplanes in Odessa, about tight corners he had found himself in, and about his fall from the wing into the sea. He embroidered a bit, but exclusively to make the story more impressive and more coherent. Pyotr told him how, with Krichevsky, he had helped Nevdachin build a small

plane. They talked about the School. Sergei advised his new acquaintance to join the gliding school, and suggested that he come to Gorki for the flying and to the wind tunnel. The old wind tunnel had been inoperative for three years now and was used as a glider workshop. The crammed building with the huge 'ears' of the diffusors at each side was quite unsuitable as a workshop, even ignoring the fact that it was frightfully cold inside the tunnel. It was quite impossible to heat it, since a draught blew through it from one end to the other; but nobody seemed to care. Vladimir Titov, the commander of the gliding school, wrote later: 'Some of the "cadets" left their families to work nearly 24 hours a day in the very unattractive conditions of those days.' But Sergei painted such a picture of it all and the frost in the tunnel took on such a romantic glamour that Pyotr decided to join the glider group directly they got back to Moscow.

They arrived in Leningrad in the morning and went out onto the station square. The monument of Alexander III hung above the square in the half light, a malevolent satire in bronze by Paolo Trubetskoi. The boys grew quiet, and no longer sang. The whole motley crowd, some with suitcases and travelling rugs, others clutching newspapers, began regrouping. Pyotr wanted to join Sergei, but the latter had disappeared; once he thought he saw Sergei's thickset figure, in a cap and new galoshes, appear for a moment and melt away.

The three days in Leningrad passed in a twinkling, without sleep. The promised three meals a day were quite forgotten. Sergei was impressed by how different Leningrad was from all the other cities he had seen, by its profound, calm pride, the severe beauty of its streets, and the secret attraction, unknown in other cities, with which its streets drew a person back through the years, forcing him to think of the past and of the future, and to find his own place in the procession of many years, even of centuries.

During the day they raced through the halls of the Hermitage. The guide, a thin blue girl, shouted after them, almost in tears: 'There are 1057 rooms here! That's nearly five miles!'

In the evening they visited Red Putilov Worker and Red Triangle Works, and then took a night train to Volkhov. This time they slept. There were no songs, and no cigarettes.

They spent a whole day at the Volkhov Power Station. The power station had just been opened, the week before. It was still draped in the red bunting of the recent ceremony. The day of their visit—what luck!—the last Swedish turbine was being started up. G.O. Graftio, the chief engineer, grew agitated when he spoke about it, but everything went off well. In a dense bunch the visitors passed through the tunnels of the Volkhov Power Station, timidly looking down where the green wall of water fell heavily. Later Sergei stared at the invisible rotation of the turbine literally enveloped in an unsteady foggy cloud, and only believed it moved because of the even low hum it made. These machines display power, he thought; they had reliable strength and solid weight, but he would never exchange all that for the lightness of a plane or the fickleness of a glider; and he once more felt with happiness how well everything was going for him at Moscow Tech.

The third day they went to the monument to Peter the Great, known as the Bronze Horseman, and inspected it from all sides, wondering why the Czar was barefooted. And Sergei remarked to himself that for such a tall, powerful man, Peter had unnaturally thin ankles.

Then, with heads thrown back, they stared up at St. Isaac's Cathedral and read the strange inscription—'O Lord, yea in Thy power rejoices the Czar!'—arguing about what it meant.

They only managed to get into the Peter and Paul Fortress toward evening. The black casemates and sinister

punishment cells of the Trubetskoi Bastion looked even more forbidding in the grey twilight.

In the train going back to Moscow they talked for hours on end about how wonderful the outing had been.

No one knew when Vladimir Titov slept. He worked at an Air Force aerodrome, studied in the Mechanics Faculty at Moscow Tech, and in the evenings became the commandant of the gliding school. Holidays and rest days he spent at Gorki.

Everyone who worked at the gliding school did so on a voluntary basis. N. N. Fadeev, V. G. Frolov, and S. I. Afanasiev read the 'cadets' lectures in aviation theory and D. N. Kolesnikov, F. M. Dubak, and D. A. Romeiko-Gurko in aircraft construction. Students who, in the daytime, sat next to each other on the same bench, in the evening would become teacher and pupil. But no one was embarrassed by that, for the school was a serious affair. Everything was just like at a real flying school. There was a medical commission, and a personnel commission. When Sergei was told to go to the doctors, he laughed, thinking they were pulling his leg. But he found that no one was enrolled without a fitness certificate. Only one concession was made for him; as a third-year student he was excused the lectures in aerodynamics. But attendance at the rest was compulsory.

Classes took place in an empty house in Belinsky St. that had been found and repaired before he came to Moscow. And the constructors had found a basement on Sadovo-Spasskaya St., a simply wonderful place, clean and dry, and even cosy for a cellar. Sergei often worked there, little knowing that five years later he would return to it and begin the main work of his life.

On Sundays they had to catch a train at Paveletsky Station in order to be at Headquarters by 10.00. H.Q. was

located in the cottage of Uncle Vanya Potatuev. The old man liked the glider boys and sometimes treated them to a pot of potatoes and served them tea. The tea was a blessing. That year winter came early; the Moscow coachmen changed over to sledges at the beginning of December. And it was cold, too. They vowed that they would only cancel gliding when it went below minus 26°C or during snowstorms. But there were no blizzards, and it didn't get that cold. So gliding went on regularly.

The instructors, Karl Wenslaw, Anatoly Senkov, and Vladimir Garakanidze, were in charge at Gorki. Whether you were going to fly, or whether you were going to run about all day pulling on the launching ropes, and what glider you would have depended on them. But there was nothing arbitrary about it. Garakanidze, Wenslaw, and Andrei Yumashev had compiled a fair programme of training flights, in which everything was set down in black and white. But all the same the instructor was the boss.

The gliders were kept in a shed that also belonged to that patron of aviation, Uncle Vanya Potatuev. There weren't many: Pegasus, a trainer given to them by German glider enthusiasts; Ever Upward, another trainer built by Romeiko-Gurko, that had earned the sobriquet 'Ever Downward' by its dogged aversion for fast flight; Chesalov's soaring glider Transcaucasian, which had become famous after the flights in Germany; and lastly, a glider built by Lyushin and Tolstykh with the fantastic name of Mastyazhart, from the abbreviations of the Russian for Heavy Artillery Workshops, where it had been built.

Just before the inauguration of the gliding school, the thermometer fell to minus 20°C, and they thought the heads of Osoaviakhim would not come. But on Sunday, January 23, everybody was there, and the hill was black with people. The gliders were taken out of the shed and quickly assembled.

'A good glider-flyer is a good pilot,' said the Second

Deputy People's Commissar for the Army and Navy, S. S. Kamenev, who opened the proceedings. He was succeeded on the tiny rostrum, hastily erected from planks, by Bazilevich, the Commander of the Moscow Military Area. 'From child's play to serious study, from glider sport to the aeroplane.' You could see the Commander's breath, it was so cold. People shifted from one foot to another, stamping their thick, felt boots on the ground and putting up with the cold. The speeches were vigorous and short. Sergei glanced mournfully from time to time at the column of smoke rising vertically from Uncle Vanya's chimney; it wouldn't be easy to fly in such a flat calm.

His fears proved well founded. When the speeches were over and gliding was to begin, Ever Upward and Saprykin failed to get off the snow. Saprykin was replaced by Artseulov himself (!) but the glider refused to take off. It was very embarrassing. The day was saved by Transcaucasian. It went rapidly and smoothly downhill toward the field where the freezing doctors were sheltering from the cold in sheepskin coats. (Ironical jokes were always being made about the doctors and they were known as 'Death's mates'.)

The inaugural programme was completed, all but one item. Garakanidze did not make his appearance. He was supposed to fly from Moscow in a balloon and present it to the First All-Union Congress of Osoaviakhim. But he didn't arrive.

Everyone thought the balloon must have come down somewhere halfway; and in the train going back to town Sergei and the other lads breathed on the frosted windows and inspected the fields along the railway through tiny peepholes in search of it. But neither the balloon nor its pilot were anywhere to be seen.

A day passed, then two, then three. And Garakanidze was still missing. The newspapers reported this accident and asked any reader who had seen a flying object resembl-

ing a balloon to report to Moscow immediately. Only one report was received. The balloon had been seen somewhere near Verbilki, flying quite high.

It was discovered that before taking off Garakanidze had detached the basket to save weight, and had flown sitting on a small board, like on a swing, wearing a thin greatcoat and high boots. Everyone thought he must be dead until, on the sixth day, a telegram arrived from Sharya, a railway station in the Northern Dvina Province, saying that he was alive and well. It turned out subsequently that he had been lifted to a height of 700 metres right from the start, and had been carried away to the north. Somewhere between Dmitrov and Tver (now Kalinin), the balloon had been caught in a hurricane that tossed it about. It was hard to imagine how Garakanidze had ever managed to cling to his board in such rough air. Then night had come. The rustle of trees told Garakanidze that the balloon had lost height and was flying above a forest. In the morning he saw houses below and landed on the outskirts of a village. Having loaded his balloon onto a sledge, he started on a four days' journey to Sharya, having established a world record by covering 702 kilometres in 15 hours. The temperature had been minus 36°C.

That event—tragicomic from today's standpoint, but heroic from the position of those days, is perhaps not worth recalling, but for one point. Garakanidze was Sergei Korolev's first gliding teacher. He was a man head over heels in love with aviation, a real romantic of the skies, to whom 'human flight' rang so pure and so exciting that it is impossible for us, accustomed to modern jets, to imagine it. And he managed to nurture a thirst for flying in his pupil that Korolev was never able to slake all his life.

Korolev flew on Pegasus every Sunday and on the holidays—March 12, the day the Czar was deposed, and March 18, the anniversary of the Paris Commune—until the

spring. He flew quite well. Indeed, everyone thought he flew best of all. And in general these boys were good judges; years later many of them became really marvellous flyers (Antipov, Aronov, Gushcha, Grodzensky, Efimov, Karapalkin, Moiseev). In those days they were extremely vain, and if any one of them did anything they would not rest until they too had achieved the same result. How envious Sergei had felt of Pyotr Flyorov when the latter mastered turns and was transferred from Pegasus to Mastyazhart and later even to Transcaucasian! And how glad he was himself (though of course he didn't show it) when he climbed into the seat of Mastyazhart. Now, at Moscow Tech, he was not simply student Sergei Korolev, but one of the elects, who flew!

But soon the sun became warmer, the snow on the southern slope of the hill melted, the ground became soft, and it became difficult to run with the tow rope. So it was decided to hold tests on the last Sunday in March. The requirements were to fly for 30 seconds and to make two turns, one to the right and one to the left. Again the big chiefs were present. (They came by train. It was risky to use an official car on Sundays; you never knew, you might land up in *Crocodile* (the satire magazine). Whenever high officials and important commissions were present all sorts of mishaps occurred, of course, in accordance with 'visitors' effect'; but this time everything went smoothly and everyone flew splendidly. Titov's happiness was complete. Wenslaw suffered terribly for each one, shouting 'Pull!' and 'Let go!' in a blood-curdling voice, then clapping the newly-qualified glider pilots on the shoulder in high spirits and calling them 'eagles'. A few days later Korolev and the other cadets received a typed certificate from Osoaviakhim.

Apart from the gliding at Gorki, the building of gliders in the wind tunnel, his theoretical studies at Belinsky

Street, and his constructor's work in the basement in Sadovo-Spasskaya St. and his studies in the lecture halls, laboratories, and workshops of Moscow Tech Sergei was very active in Zhukovsky Circle (AKNEZH).

The Zhukovsky Circle put stress not so much on science as on the making of various machines, mechanisms, and apparatus. You could get good advice there from experienced engineers (naturally, giving their services free), and check your calculations; but the main thing was that you could argue with other people as hipped as yourself. Various references and certificates were issued there, and quite 'fake' indents for materials. The suppliers knew quite well that they were faked, but even so they sometimes handed things over, moved by the youth of the client and by the naiveté of his references to the authority of the 'Father of Russian Aviation'.

In the spring of 1927 Sergei Korolev met Savva Krichevsky at AKNEZH. The latter was his junior at the Tech, but had been working in AKNEZH for some years. They decided to build together a light plane—which they labelled SK (luckily their initials were the same). They worked for three or four months and wasted much time on arguments and quarrels; both lads were extremely stubborn, and each regarded every remark of the other as an infringement of his author's creative independence. Apparently, they were very much alike, and that was the trouble. Nobody was surprised when the partnership broke up. Savva began designing a new plane, while Sergei continued working on the SK, but only intermittently, for he lacked time. (Despite the split, however, the two remained friends, until Savva's death. He died quite young in 1935.)

Sergei lacked time because he started work at Aircraft Factory No. 22 (still called the Russo-Baltic from habit) in Fili in May 1927. From then his constructor's status becomes 'official'. Now he was busy right round the clock.

He forgot when he had last been to the theatre or the cinema, when he had last drunk a jar of beer or even simply when he had last wakened without an alarm-clock. Occasionally he managed to have a glance at a newspaper. 'Nine Elephants from Germany for the State Circus', '400 Phone Boxes Installed in the Capital', 'Observatory Opened on Bolshaya Lubyanka St.'. There was a mass of interesting things going on around him, but he knew nothing of them and didn't manage to find out.

The meadow in Gorki was ploughed up, and gliding had to stop. But how he wanted to fly! And he wasn't the only one. Having got their gliding certificates the lads from the gliding school could not sit quiet, so they scoured the countryside round Moscow looking for a suitable ground. One day Anatoly Senkov rushed in happy and excited waving a map.

'Look what I've found! The village of Filino behind Khimki. There's a little mound and a field, all we need.'

Pyotr Flyorov was sent out to reconnoitre. He rode to Filino by bicycle and the same evening reported the results of his investigations with plans of the terrain made on the spot spread out in front of him.

'The ground's suitable for flying. We just need to clear some bushes.' Flyorov can claim to be the 'godfather' of the spot that is now known to all Moscovites as Planernaya (Glider) Station.

The gliding school was getting ready for the All-Union Glider Rally in Koktebel. A training group was organized, and flew and repaired the gliders. And Korolev knew that his dream was at last coming true: this time he would see Koktebel.

Everything turned out even luckier than he had hoped. Lyalya wrote to him from Kharkov inviting him to come to the Crimea, where she and her parents were going to spend their holidays at Alupka.

For the first days in the Crimea Sergei was unable to alter the rhythm of his Moscow life. He always hurried somewhere, climbed the mountains, swam out of sight. Then suddenly he felt he was tired, and it dawned on him that he had no need to rush and run, that he could walk with Lyalya in the Vorontsov Park for an hour, or two, or three, even a whole day, and lie on the rocks with his eyes closed and his face to the sun. The carefree days in his life added up to no more than several weeks, and those days in Alupka were probably the most carefree of them all.

But everything comes to an end, especially carefree days. Lyalya left for Kharkov, and Sergei for Koktebel. After the bright, sappy green of Alupka Koktebel struck him as deserted and desolate. He didn't immediately appreciate its gentle water-colour beauty, the softness and refinement of its colours, its exceptional air, golden with sunlight, smelling of wormwood and the sea. The poet and painter Maximilian Voloshin has justly written about these places:

> I've seen a lot. To this world's wonder rare
> Paid homage in my poetry and art.
> But my breath's too short to breathe this air,
> My voice too small for me to be its bard.

Voloshin, incidentally, had a very direct connection with the gliding events. In 1920, while walking on the outskirts of Koktebel with K. K. Artseulov, already then a famous flyer, he went to the top of Mount Uzun-Syrt. There they stopped at a precipice on the southern slope of the mountain. A gust of wind blew Voloshin's hat off. Instead of falling down the cliff, however, it rose higher and higher and then slowly descended on the sloping northern side. He threw his hat over several times, and each time it was carried up and up. 'There's a rising current here!' Artseulov cried. 'This is the place for gliding!'

Three years later, thanks to Artseulov's initiative, the First All-Union Glider Rally was held on Mount Uzun-Syrt, and was held there annually with few exceptions until 1936. Korolev's first rally was the fourth of the series. After the big meeting in 1925, in which over 50 gliders took part, the trials of 1927 were quite modest (none were held in 1926). The gliders were slowly hauled to Uzun-Syrt on *mazharas*, Lyushin and Tolstykh's Mastyazhart glider, Tolstykh's new IT-4, Chesalov's Transcaucasian, Tikhonravov, Vakhmistrov and Dubrovin's Firebird, Cheranovsky's Dragon, Gribovsky's G-2, Ivensen's Seagull, Yakovlev's AVF-20, Yakovchuk's KPIR, and two gliders from Kharkov, the Shpak and the Gorobets.

'Ah, you're here, too!' cried Yakovchuk, seeing Korolev. 'You've done it at last!'

Sergei didn't like Yakovchuk's high-handed patronizing tone and was silent. He had many acquaintances there: Pyotr Flyorov, Sergei Lyushin, and Igor Tolstykh, with whom he had flown at Gorki and Kraskovo; Vladislav Gribovsky and his old friend Alexei Pavlov, whom he had met in Kiev. But after Alupka and the short sweet days spent with Lyalya he was in a subdued mood, sought solitude on the beach, and even found lodgings in a small cottage by himself. Nearby were the quarters of Gribovsky, Lyushin, and Pavlov. Very soon, however, his solitude was disturbed by terrifying elemental forces.

One night Lyushin was wakened by a strange noise and crashing, as if somebody was trying to break into the house.

'Who's there?' he asked.

'Who's there? Answer, or I'll shoot.' Gribovsky drew his revolver. In 1927 he was working as an instructor at the shooting and bomb-throwing school in Serpukhov and, as an Air Force pilot, he was entitled to carry arms, of which he was very proud. His threat had no effect; the house was shaken again.

'Brothers! It's an earthquake!' Pavlov was the first to guess. They all rushed out onto the terrace. From all sides came the shouts and cries of people. It was one of the last echoes of the famous Crimean earthquake of 1927.

It wasn't safe to stay in a two-storey building, so Sergei Lyushin asked Korolev to take him in. They shared a room and soon became friends. In Koktebel 'Black Seryozha' (Korolev) and 'Ginger Seryozha' (Lyushin) were identified by the colours of their leather jackets.

Sergei Lyushin was five years older than Korolev. He, too, was studying at Moscow Tech, was interested in aviation and had begun building gliders back in 1922 when he had helped Artseulov with his A-5. In 1923 everybody was building gliders. While Sergei Korolev was making first sketches of his K-5 on Platonov Pier in Odessa, Boris Cheranovsky in Moscow was getting on with the construction of his first 'parabola', Igor Tolstykh with his Black Kite, Nikolai Anoshchenko and young Sasha Yakovlev (the future Constructor General A. S. Yakovlev) were building their Macaco, a glider of the simplest balance type, Vladimir Vakhmistrov with Alexei Dubrovin and Mikhail Tikhonravov their AVF-1 (meaning the first glider of the Air Force Academy from the letter's Russian initials), and Vladimir Pyshnov his Martlet. Later Lyushin had also begun building a glider with Anatoly Jardinier. He had taken part in the big Koktebel rally of 1925. In short, he knew everyone there, and everyone knew him. For such a tyro as Korolev, acquaintanceship with Lyushin meant striking it rich.

The forces of repulsion that, as physics tells us, are characteristic of like charges, and which had prevailed in the Korolev-Krichevsky alliance, this time gave way to forces of attraction, for Korolev and Lyushin were very much unlike. Ginger Seryozha's common sense, deliberate concentration and organizational incompetence matched beautifully with the young vigour, resolution, speed of deci-

sion, and a wonderful ability to make everything move, of Black Seryozha.

The Koktebel days began, with disputes in the technical commissions, and gliding from dawn to dusk. Gribovsky ran about mad as the devil; the technical commission had rejected his G-2 glider. It was better than the KPIR, he shouted, but Yakovchuk flew, and Gribovsky wasn't allowed to.

'The tail is too short,' was the commission's verdict.

'Here are the calculations,' Gribovsky said, holding out notebooks with columns of figures.

Igor Tolstykh, too, was dissatisfied; he wanted to test his IT-4 himself, but he arrived late and the glider was testflown without him. The high-level disputes in the technical commission and Igor's sufferings were an aspect Korolev was not yet ready for. He just wanted to fly. To tell the truth, he envied the flyers more than designers: Evgeny Ptukhin on Firebird, and Sergei Korzinshchikov on Dragon. Korolev adored flying.

He liked it, but that autumn he could not boast of any outstanding performances. Many of the lads from their gliding school flew better than he. Efimov was even allowed to fly Transcaucasian. Pyotr Flyorov flew on the AVF-20, and cracked it up on landing, escaping himself without a scratch. Pyotr was sent back to Moscow early, but to be honest, he flew better than Sergei. As for Gribovsky! He succeeded in persuading the technical commission, took off in his glider and soared higher than Yakovchuk. And how stylishly he landed! Yakovchuk landed in the valley, and he landed on the mountain.

Korolev was always very proud. He knew that success only came from hard work and used every chance to get air-borne. He didn't do well on the IT-4, it was too sensitive, but did better on Mastyazhart. Lyushin helped him there, too, telling all about the awkward character of his glider.

How happy he was up in the sky! It wasn't a bird-like happiness in unaccustomed movement; he got satisfaction not only from the feeling of oneness with the machine (which has so often been described), but also, and no less, from understanding its behaviour—why it tilted a little to the right, why its wings lurched, why it nosed down. The span and profile of the wing, the lift coefficient, the density of the air, all the symbols in the formulae, all the figures in the calculations became realities in the air instead of abstractions and from being dead on paper came alive here up in the clouds.

They were all photographed together as a souvenir with Yakovlev's AVF-20, ten quite young glider lads. In the sixties this photograph hung on the wall of Korolev's home study. Sometimes he would come up to it and take a long look at it, and the gay young faces. 'That one in white shorts is Karapalkin. He enrolled later in a flying school. The husky chap next to him is Ivan Krysanov. He flew badly and soon quitted. That's me. The shock-headed one is Vasily Efimov. He was a carpenter, later became a works test pilot, and was killed in a crash in Douglas in 1947. That's Grodzensky. He ferried planes during the war, flew to America, got iced up and was killed. Anatoly Senkov. He looks like a real pilot in helmet and gaiters. Later he joined the Central Aerohydrodynamic Institute. Next is Sergei Lyushin. That's how he looked thirty years ago. I asked him to join me, but he refused, and spent all his life in aviation. Karl Wenslaw. He's dead too. And that's Pyotr Flyorov. The rockets finally converted Pyotr, though planes gripped him tight for a long time. Maxim Moiseev. He became a fighter pilot, and was killed in an air battle... .'

Ten young fellows without an inkling of where their roads would lead smiled at the Constructor General from the old photograph.

The train steamed toward Moscow. Sergei lay on an

upper berth. Down below the lads were playing cards. He was surprised at himself: a gambler in spirit he was indifferent all his life to cards. He lay dozing (they slept little sleep these last days), sleeping, thinking. The train was a line summing up his life. Something ended there in the train, and something new began. A year had passed since he left Kiev. It has been a good year: the Tech, gliders, work. Everything was going as it should. Only everything needed to go faster. And Lyalya. Lyalya should be with him.

CHAPTER 13

In November a rumour stirred the gliding school and swept through the Kraskovo suburb with the speed of an electric discharge: the Osoaviakhim gliding group had received a plane! And what is more, the plane flew! It turned out to be true. In a corner of one of the hangars of the Central Aerodrome a French Henriot trainer, not a very old one, with paint intact, and with a 80 horse-power Rhön engine that did not need repair, was standing on its four wheels. Three years or so ago 30 of these planes had been procured for the flying schools, and now the glider people had succeeded in 'winning' one of them. It took everyone's breath away. They decided to fly and to start right away. The medical commission was ignored. Karl Wenslaw took the lads one by one and sped over the field so that the bracing wires creaked.

Korolev knew nothing about it. He hadn't gone to the airfield that day and did not take part in this 'flying festival'. While Pyotr Flyorov was telling him about the Henriot, Sergei looked about with a very absent look, giving the impression that all this was of little interest to him, that he was a grown-up, busy man not up to such pranks. But on the next day he was at the aerodrome, wearing a leather helmet and goggles and a long scarf

wound round his neck, in the fashion with aviators in those days. He would not say where he had got all these adornments but adjusted the goggles and climbed into the plane.

'Take those goggles off!' said Karl sternly. 'You'll cut your eyes if we should nose-dive during take-off!'

Sergei complied.

'Here we go!' said Karl.

But they didn't 'go', let alone fly. The Rhön started up, but instantly stalled. They fiddled about the whole day getting dirty and smelling of castor oil, but it wouldn't start.

'Those goggles of yours put the evil eye on it,' said Karl.

Sergei held his tongue. Everyone was as angry as the devil, and he most of all; how very stupid all his masquerade looked now. And he never did manage to fly in the Henriot. They fiddled about with it for a long time, taking it down, and reassembling it. At last it was taken away somewhere, and that was that.

The gliding station in Kraskovo was opened in December. Korolev now worked mainly with the constructors D. N. Kolesnikov, N. N. Fadeev, and D. A. Romeiko-Gurko. He watched closely and attentively, wanting to try himself, but knowing it was too early; he needed to learn more. He helped building parts for gliders and equipment for the gliding station.

Toward spring the school enrolled a new intake. Many young 'uns' came, among them two girls, Tina Akulina and Valya Stoyanovskaya. Famous pilots sometimes came to Kraskovo and gave a display of high-class gliding. Anisimov, a fighter-pilot, well-known as a stunt-flyer and in those days no less famous than Chkalov was later, volunteered to fly the Transcaucasian and did it beautifully. For a lark he changed over to Pegasus. The launching rope was stretched to the limit, and Anisimov took off; but suddenly the glider wobbled and fell. Anisimov expressed

his opinion of it in choice Russian language and left in anger.

Korolev noted with annoyance that the lads' enthusiasm was waning. No matter how much he agitated they only flew three or four times during the whole winter. And the trouble was that you couldn't glide alone, for you couldn't get the glider up by yourself. In the spring too they flew without much heart, much less than in Gorki. But then spring is a very busy time. Examinations were beginning and Sergei was completing his course project, a steam boiler. Yuriev had suffered defeat in his dispute with the board of studies: the aircraft students were not exempted from the traditional boilers. And the amount of work at Fili had increased as well.

That summer the factory where he was working was visited by a group of strangers accompanied by top officials from Aviatrust. Their clothes were such that even from a distance, without hearing their voices, you immediately recognize them as foreigners. At their head strode a handsome, dark-haired man in a light check jacket and a cap of the same fabric with a long peak. Listening to the quick speech of the interpreter he nodded politely and frowned. It was Paul-Aimé Richard.

The visit of the French aircraft designer to Factory No. 22 had its preliminaries. In those years the leading Soviet aircraft designers were Dmitry Grigorovich, Nikolai Polikarpov, and Andrei Tupolev. Grigorovich specialized in hydroplanes having built his first flying boat in 1913. The seaplanes Korolev had flown in Odessa were of his design. In the Mid-twenties Grigorovich was head of the Division for Experimental Naval Aircraft Construction (OMOS) in Leningrad. Several planes had been designed there, but their primary attention was engaged by an open-sea reconnaissance plane (ROM). When its tests had begun

it was found that it did not meet all the requirements. Grigorovich struck a patch of fatal failures. His naval mine-layer, and his torpedo-carrier, and his ship-borne fighter, and his projected ship-borne reconnaissance plane with folding wings never got into the air; every time, something or other prevented the design work from being completed. Aviatrust was dissatisfied. The naval people who had ordered the planes harassed and hurtled it incessantly. Grigorovich was nervous. Everything was coming unstuck. Almost every person has such spells of hard luck in his life. And so do whole working groups and teams.

OMOS was transferred to Moscow in November 1927 to Factory No. 22 and given a new designation, the Third Experimental Department, OPO-3, but that made no change. The fact remained that for three years running Grigorovich's team of designers had produced no useful results. There was talk of a change of leadership. Aviatrust, of course, could have found a worthy candidate for the post of Chief Constructor among its own engineers, but it was a custom of long standing in Russia to regard foreigners as more clever than the folk at home, and accordingly they began to look for a foreigner. The German Rohrbach demanded too much. He was rejected, and now Richard has turned up. Aviatrust had invited him to come and work in the USSR especially in order to improve matters with hydroplanes. He was an acknowledged expert in flying boats. In fact, he did not have any great constructor's experience, and his successes were quite modest. Up to then he had built one very large hydroplane, the Penoch, which had crashed during a test flight. The Frenchman was literally and figuratively broke and decided to accept Aviatrust's offer. In September 1928 Grigorovich was relieved of his job.

It was not difficult therefore to guess the purpose of Richard's visit to Factory No. 22. It offered him excellent production facilities. So, while preparing for his trip to

Koktebel, Korolev took a Russian-French dictionary with him—he was sure that he would find Richard his boss on his return, and the Frenchman did not know a word of Russian.

The Fifth All-Union Glider Rally was probably the least interesting of all those that Korolev attended. In particular, there was nothing actually to be tested. Only ten gliders were taken up Mount Uzun-Syrt (or Mount Klementiev, as it was usually called after the absurd death in 1924 of the pilot Klementiev in a glider of his own construction). They included Gribovsky's G-2, Cheranovsky's Dragon, Senkov's KIK, Chesalov's Transcaucasian, Tikhonravov, Vakhmistrov, and Dubrovin's Firebird, quite a familiar company, in short, and the word 'trials' as applied to them wasn't very appropriate. What was being tested was not the gliders but the pilots.

An experienced pilot from the Kachin School, V. A. Stepanchonok, had been appointed instructor for the young glider-flyers. Lean, with protruding ears, and a wolf-like face, he was strict and merciless toward offenders against discipline. He began by assembling everyone and explaining to them how they were to fly and in what order.

'You are going to fly in the KIK. While one is in the air, the other gets ready. Those two are not to carry anything, and not to come near the ropes. Lyushin will fly first, while Falin gets ready.'

Ginger Seryozha flew so badly that everyone sighed. The glider went into a sinusoidal curve and only a miracle prevented it from hitting the ground. When Lyushin landed, Stepanchonok said to him: 'Another flight like that, and I'll take you off the starting list.'

Korolev's turn came. He did not do much better. Stepanchonok said to him: 'What are you jerking the stick for? It must be in neutral. The glider flies itself.

Your job is only to help it from time to time. You're lifting the nose so high sand pours out of the skis.'

The more Korolev studied Stepanchonok the more he liked him. Many thought him fault-finding, but actually he was always to the point, explaining mistakes, praising if everything was right. A little blunt? Probably. But his bluntness was not humiliating.

The best glider that year, probably, was Dragon. Sergei Ilyushin mistrusted it for some reason or other and with the authority of the technical commission he forbade flying it higher than 50 metres. Stepanchonok argued with Ilyushin and proved that the glider was a splendid one, but was forced to submit. But the day Ilyushin left for Moscow Stepanchonok took off in Dragon and climbed to an altitude of one kilometre! The wind was strong and got stronger hour by hour. The duty man came running from the met station and said a storm was brewing. When Stepanchonok landed it was already blowing a gale. The gliders creaked and whipped from side to side. Strong gusts twisted their fragile wings. The lads were at a loss what to do.

'Dismantle the gliders!' Korolev shouted. 'We'll put everything in the ravine and cover it with a tarpaulin.'

The wind made it difficult for him to make himself heard. He quickly distributed the people, some to dismantling the gliders, others to carrying them down. That was probably the easier job, downhill with the wind blowing in your back. An old lorry came to the rescue; without it they probably would not have managed.

The marquee that served as a hangar shook violently, the central pole jumped and was pulled out of the ground. Its collapse was imminent, but there were still two gliders inside, the G-2 and the KIK.

'Take Gribovsky apart!' Sergei shouted. The moment the disassembled G-2 was taken out of the tent, it collapsed.

The next morning the meteorologists said that the wind had reached a velocity of 30 metres per second. A heap of splinters was all that remained of the KIK. And Chesalov's glider, though disassembled and covered over, had sustained serious damage. But gliding was resumed on the following day. After the destruction of the KIK Dragon was used for gliding.

It was a very 'picturesque' glider, painted to look like a real dragon; but, as the pilot and glider-flyer, Igor Shelest, wrote, 'its "scales" reminded one more of an ordinary fir cone than of the skin of a monster'.

Stepanchonok began take-offs from a quarter of the way up the northern slope, then took the start up to half-way, then to three-quarters. At last he said: 'Tomorrow we're going to fly from the top.' At last the long awaited day came when he gave permission to fly from the peak of Uzun-Syrt. This was not just a gift to Black Seryozha, but acknowledgement of his achievements. Bursting with pride, but glancing sideways to hide the delight shining in his eyes, he told Pyotr Flyorov in a quick, off-hand fashion: 'You can't imagine how beautiful Uzun-Syrt looks from up above.' He had to speak hurriedly for he knew that Pyotr himself was to fly from the upper slope in two hours' time, and that his triumph would be short-lived. Damn it all, but he was conceited!

It was a long hard job to pull the gliders up to the very top. They hired a horse. The lean mare slowly, like in a dream, dragged them up the grey, thorn-covered slopes. Korolev walked alongside her playing with a switch to keep her from falling asleep. At the top of Uzun-Syrt he saw a dark figure standing apart from the others. Maximilian Voloshin, tall and stately, wearing a long woollen sweater, with a metal band round his head, was frozen in proud immobility. As the gliders soared and sailed silently toward the valley he watched them, moving only his eyes, without turning his head.

In Moscow Tech there was quite a strong group who supported Trotsky and held underground meetings there. Trotsky came here, making speeches and asserting things that he had only yesterday disavowed in the newspapers. On the tenth anniversary of the October Revolution there was an anti-Soviet demonstration. In autumn and winter of 1927-8 classes were frequently interrupted. Prof. Ramzin lectured not so much about boilers as about politics. Prof. Charnovsky stated that only idiots could think of producing tractors at the Red Putilovets Works. The lecture halls rang with whistling. Political sympathies sometimes determined examination marks; and former Rabfak students were 'ploughed'. In 1928 the first of the 'Party thousand' and 'trade union thousand'* were enrolled in the engineering colleges and the July plenary session of the Central Committee of the All-Union Communist Party (Bolsheviks) raised the question of speeding up the training of engineers.

The end of 1928 was a time of changes for Sergei Korolev. There were changes in the syllabuses of Moscow Tech. And there were changes in the administration at the factory. His attitude toward gliding was changing, too: returning from the Crimea he decided that he had had enough of being an apprentice, and that he must build and fly a glider himself. He talked it over with Lyushin one of the first days after their return to Moscow.

'I'd like to build my own sail plane,' Ginger Seryozha said casually.

'So would I,' responded Korolev quickly. 'Let's do it together.'

'He insisted that I go home with him that very evening, and we started work right away,' Sergei Lyushin recalled years later. And this was one of Korolev's most characteris-

* Members of the Party and trade unions mobilized to receive higher education.—*Tr.*

tic traits. Smug, complacent holding forth of any kind and 'day dreaming' as a cover for passivity were absolutely foreign to him. A thought, an idea had to be acted on with the maximum speed. He never said: 'It would be nice to do it', or 'we should try it'. He did it and tried it at the same time. Later in his space years this feature irritated many of those working with him, for it seemed that he tackled a job without thinking it through. People were slow to understand that he thought more quickly than others and did so very rationally, no more than what was needed in order to begin.

When Grigory Balanin got a two-room flat in Alexandrovskaya Street toward the end of 1926 Sergei had originally been put in the bigger room which also served as dining-room and sitting-room. But his mother soon realized that he needed a separate room and gave him the bedroom. He was now a quite grown-up lad with his own concerns, his own affairs and new, earnest friends. He had changed much in the year and a half in Moscow. He'd grown a small moustache, and bought himself a good suit, a fashionable shirt with a separate collar, and had started wearing a tie. The rosy-cheeked student in the faded Russian shirt has imperceptibly turned into a man of substance. Now he had a room to himself, a nice square room with a big window overlooking the yard, and an old cupboard with a 'hunting' motif (dead ducks carved on the doors), a divan, and a table in the middle of the room with a drawing board that only rarely was put away behind the cupboard. Near the wall were another three or four drawing boards—it was a small, home constructor's bureau. A card on the wall read: 'Having finished your business, don't forget to leave' with 'Get out!' written underneath. There was an ash-tray filled with fag-ends, and rose-coloured dust from erasers in the cracks in the floor. Korolev lived for ten years in that room.

So they decided to build their own glider. And not just

a glider, but a sail plane. Korolev quickly formulated the task.

'This is an experimental glider. What will be new about it compared to existing designs? First of all, absolute reliability, even at the expense of aerodynamics and speed.'

This project, the first he actually realized, already shows how concerned he was with the problem of reliability. The machine is built to serve man. That is the only justification for its existence. And an unreliable machine cancels that out. It's useless, senseless, faulty in principle, and therefore harmful. That conviction he maintained all his life from Koktebel, the name they chose for the glider, to the *Soyuz* spacė vehicle.

The first calculations showed that the glider would have to have a large span and long wings. A smaller area would raise the loading on the wing. Oleg Antonov, the aircraft constructor, noted later that because its weight had been distributed away from the centre of gravity the glider Koktebel behaved 'extremely quietly' in flight. Accurate balance and rational lay-out were the prerequisites for stability in flight.

The preliminary project was presented before the technical commission of Osoaviakhim. Or rather, a commission made a report, and Lyushin and Korolev answered questions.

The project was approved in principle. The resolution stated: 'Money should be paid out to make the working blueprints, and a place found for construction.' It was all wonderful though it was not quite clear who was to make the blueprints and who was to look for the working space. They themselves found helpers. Lyushin and Pyotr Dudukalov drew the wing and tail, while Korolev and Pavel Semyonov drew the fuselage and controls. They spent every evening seated at drawing boards, except New Year's Eve. The slide-rules 'smoked'. At the same time Korolev was thinking about who could take it on to turn

these blueprints into metal and wood. Despite his great talent for persuading and firing others with his ideas it was hard to find a contractor. After being turned down in several places he made a deal with the Shchepetilnikov Tram Depot and the workshops of the Zhukovsky Air Force Academy. The depot agreed to do all the carpentry work, to make frames, ribs, and spars. The Academy workshops were to make the metal parts.

By day Korolev worked at the factory, then ran to the tram depot, fitted parts and made corrections, consulted the foremen, then rushed to the Tech. But all that didn't seem enough to him. One evening, in the beginning of February, he rushed into Lyushin's room (Lyushin lived near the Tech, by the Krasnye Vorota (Red Gates)) and cried from the threshold: 'Tomorrow morning we're going to the medical commission!'

Lyushin raised his eyebrow in astonishment.

'A group of flyers has been selected. Six,' explained Korolev. 'We're going to be taught how to fly a plane. Tomorrow there'll be medicals at the Academy. We mustn't be late.'

'I'm not going,' replied Lyushin. 'Don't you understand, I won't pass the medical. It's impossible for the atrophy of the deltoid muscle not to be noticed.'

'But they may not spot it.'

'No, I'm not going to go.'

'Yes, you are!'

Lyushin knew that he couldn't get rid of him and that it was useless to argue.

Next day Korolev came and dragged him to the commission. And of course Lyushin was rejected, while Korolev passed without comment. Lyushin was dispirited.

'I told you, I shouldn't go.'

Korolev tried to cheer him up.

'Don't lose heart. The doctors are just being fussy. Pyotr Flyorov has been rejected, too. They've found cardiac

neurosis and something wrong with his eyes. It's clear they're being fussy. But we'll think of something.'

'What's there to think of?' Lyushin wondered.

'Something,' Korolev said with conviction.

He proved right. Stoklitsky, the chairman of the sports section, an engineer and a pilot, yielded to his pleas and on his own responsibility permitted Lyushin to fly.

The flying school was being set up literally from scratch. There was absolutely nothing, not even an ordinary school blackboard. Things were chalked up on a bit of wing. And if there had been a blackboard there would have been no place to put it, as the school had no premises. By fair means or foul, Osoaviakhim had managed to obtain a British Avro 504K biplane, which they Russianized affectionately to *Avrushka*. This plane, with its incredible name—No. 353 invented by some nameless wit, was very ancient, decrepit, and classified as 'third-rate', i.e. it couldn't be worse. It was a trophy from the Civil War. Its air certificate said that it was 'permitted only to make smooth turns'. The only instrument was an altimeter that gave false readings, though there was also a glass in which oil bubbled, so providing information on the state of the oil lines. *Avrushka*'s engine could only be controlled between 900 and 1200 r.p.m. When landing, it was necessary to switch off the ignition. On the ground the machine was practically unmanageable. How this obsolete contraption flew passed understanding, but fly it did! And in Stoklitsky's opinion it would have been hard to find a better plane for training, for anybody who could fly *Avrushka* would be able to fly any other aircraft. In any case, the flying school's lack of equipment was more than made up for by the abundant optimism of its founders and students.

Lessons at first were irregular. They could not find a good instructor anywhere. Pilots came, mainly from the Zhukovsky Academy, gave one or two lessons, and disappeared. A man was needed who had a feeling for the new

job and did not just formally fulfil a public obligation (the instructors received no pay).

Dmitry Koshits, a pilot and a glider enthusiast who had taken part in every glider rally at Koktebel, proved just such a man, gay and very sociable, and with an inexhaustible fund of jokes and anecdotes. Everybody liked him at once. His charm could not fail to attract Sergei Korolev. In spite of the difference in their ages and status (Koshits was six years older) they had much in common. Like Korolev he had been brought up in a family of intellectuals. Like Korolev he was living with a stepfather. Like Korolev he was mad on aviation, had a passion for gliding, and could not imagine life without flying.

The school now worked regularly, strictly to timetable. In winter they flew on Sundays, and in spring and summer every other day after work. None of the six—Grodzensky, Egorov, Efimov, Korolev, Lyushin, and Pinaev—was ever late. Pyotr Flyorov, though rejected by the medical commission, had also managed to get into the school. He was a probationer at the Air Force Academy and had a pass to the Central Aerodrome. The mechanic Sklyankin went home at four o'clock, and Pyotr in fact did his job. Koshits, impressed by his selfless devotion, took him up and taught him to fly. But being a disciplined man setting an example of a serious approach to business, he said from the start that he would not let him fly solo.

Quite a few planes were based on the Khodynka Field, where the Central Aerodrome was located, and sometimes the lads from the school were not allowed to fly in daytime 'to keep them out from under our feet'. There was nothing they could do about it, and they would watch in misery and envy as brand-new de Havilands took off and landed, and sighing would resume repair work on their *Avrushka*. It was amazing how there was always something in it that needed fixing. The nastiest job was washing it down. The exhaust left an oily black trace on the left wing,

and it had to be washed off with soap and hot water, lying on your back. Dirty drops of water fell on your face and trickled down your arms. Koshits would sit nearby and cheer them up with stories.

'Do you think it's possible to put this plane into a spin?' he once asked Lyushin and Korolev nodding at *Avrushka*. 'You should know, for you're aviation engineers.'

'It's hard to say,' said Korolev, after reflection. 'It's impossible to judge by sight.'

'I can't remember once when *Avrushka* disobeyed my orders,' said Koshits, and took off, taking Lyushin up with him. The airfield gasped. *Avrushka* proved to be very obstinate and didn't want to go into a spin, but Koshits forced her somehow. The obedient little plane quickly pulled out of the spin. Koshits, however, was not satisfied, and made Lyushin repeat the manoeuvre. They landed safely.

Lyushin was as calm as usual, as if there had been no spin. Koshits was excited and laughed nervously: 'Koshits will never be killed!'

Korolev recalled these words with pain some years later, when Koshits was killed in a transport glider.

On 25 April 1929 the Sixteenth All-Union Conference of the Communist Party adopted an appeal calling for the organization of competition in all fields of socialist construction. It was the time when the 'shock worker' (*udarnik*) movement was born. The colleges did not remain aloof. There were whole groups of shock workers in Moscow Tech. Any one who was late or guilty of other student offences was apt to find himself called a 'pseudo-shock worker'. One student challenged another, for example, to socialist emulation in compiling the best summary of the theory of engines. 'Finish the Tech in three-and-a-half years!' became the slogan. The training of engineers was a very acute problem, as can be seen from the fact that all the final-

year students (with very few exceptions) were already working as engineers, sometimes in very responsible jobs. Korolev, for instance, while still a student, deputized for the chief of the centre section group at the factory. It might seem at first glance the shock worker movement was inappropriate in colleges but this was a much needed political campaign that helped in short time to solve the country's vitally important economic and manpower problems.

It was decided in 1929 to 'speed up' graduation at Moscow Tech by cutting the number of tests and examinations and the time set for diploma projects. Prof. Yuriev suggested to the students of the Aeromechanical Faculty: 'Let us arrange graduation by an abortive method. Why should we set tests in designing if a man has already been working for several years as a designer in a constructor's bureau?!'

Korolev liked the proposal very much. He catastrophically lacked time for building his glider. He had to have the glider ready for the next rally in Koktebel, or bust. So, when themes for diploma projects were discussed, sly Korolev decided to save several months on it. He proposed as his theme the light plane he had started making with Savva Krichevsky two years before. The proposition was accepted. A. N. Tupolev was to be his supervisor.

'Korolev was one of the "easiest" diploma students,' Tupolev recalled many years later. 'I saw at once what he was after, and it was sufficient just to help him a little, to make some minor corrections here and there. I quickly saw that this man had the ability to get to the root of the matter. He already made an excellent impression on me then as regards both his personality and his talent for design. I would say that he was a man with unlimited devotion to his job and his ideas.

'From the very beginning I felt a sympathy for Korolev, and he too, I must say, responded with great sincerity.'

Korolev was not one of those students who agree every step in their work with their supervisor, and did not trou-

ble Tupolev with questions for which the latter was only too thankful, for he was day and night at the Central Aerohydrodynamic Institute; 1929 was a decisive year for him. His new plane, famous later under the name *Wings of the Soviets*, was to make its maiden flight at the May Day demonstration. M. M. Gromov subsequently took it on triumphant flights to the delight of Berlin, Paris, Rome, London, and Warsaw. In the autumn of 1929 S. A. Shestakov and his crew flew the ANT-4 from Moscow to New York, via Siberia, the Far East, the Aleutian islands, Alaska, and British Columbia. (Korolev kept newspaper cuttings with photographs and reports of these flights to the end of his life.) So Tupolev didn't bother about his diploma student, the more so that the latter had a head on his shoulders.

Korolev defended his project—the light plane—in December 1929, but only six weeks later Order No. 45 dated 9 February 1930 was issued stating that Korolev (without initials; much later, in 1948, when he needed a copy of the document, the personnel department of Moscow Tech was rather perplexed by their absence from the order) had completed the syllabus in Aeromechanical Faculty of the Moscow Higher Technical School and was qualified as an aeromechanical engineer. The same order contained the names of other aviation specialists (sometimes, but it didn't matter, without their initials), whose names are now well known in the world of aviation: Semyon Lavochkin, Alexander Makarevsky, Ivan Bratukhin, Max Teitz, Lev Kamennomostsky, Vladimir Baikov, Vladimir Avaev, Anatoly Brunov, Nikolai Fadeev, Nikolai Sokolov, Vladimir Teplyakov, Samuil Sopman, Alexander Silman, Ivan Pugachov, to name a few. The list was quite long. In short, as the Dean said, 'it was a quite strong graduating class'.

All that happened in the winter. In the summer of 1929 Korolev had spent all his time outside working hours at the factory, flying at the Khodynka Field and building his glider.

A place had been found at last on Begovaya (Race Course) Street where construction could begin. The word 'place' is probably more appropriate than 'premises', as it was an open shed with a roof, earth floor and three walls of rough planks sheltering a tethering rail for horses. Nearby was a shed where the assembled parts were locked up at night —such was the future Constructor General's first 'assembly shop'.

Work went on in the roof till dark. Sergei somehow managed to get the riggers interested in the job, and they no longer looked on it simply as overtime, but began to feel themselves 'co-authors' with the young designer. Other gliders were also being built near Korolev's tethering rail. Sometimes Gribovsky, an old acquaintance from Kiev, dropped in. (He was already regarded as a maestro, being not only the author of several gliders, but even of two planes, one of which, the G-5, had been built in Orenburg and flew well.)

'What are you building here, Seryozha?' he asked, carefully inspecting Korolev's creation.

'Well, this time I want to fly my own glider.'

'But will you manage?'

Korolev watched his future Crimean rivals with apprehension. That one's quite ready, that other one is being covered with percale, Cheranovsky's Gnom, stubby, resembling a bomb, shone with fresh paint, ready to go. Would he really be late?

At Osoaviakhim they refused to believe it when Korolev and Lyushin announced that their glider was ready for the rally: no one had expected them to build it so quickly.

Before leaving for the Crimea another important event occurred of which Korolev was extremely proud. He made his first solo flight in an aeroplane. At the end of July Koshits gave permission first to Pinayev and then to Lyushin to make solo flights. Korolev was dying with envy, but didn't show it. Koshits wanted him to get rid once and

for all of the habit he had acquired in gliding of moving the controls too broadly. Korolev's hour came at last at the beginning of August.

Koshits didn't warn him in advance, but when he saw the instructor disconnecting the speaking tube and taking the cushin from his seat, Korolev knew he was to fly solo and at once became very calm, affectedly so, a little short of yawning.

'So your job is to take off, circle, and land,' Koshits said to him.

The latter nodded in response.

'May I take off?'

'You may.'

Avrushka's engine started first go which was considered a good omen. Korolev took off in the direction of the present Khoroshevo Highway, made a very neat turn, and landed. As he climbed out of the plane he couldn't suppress a radiant smile. Koshits made him a right royal present.

'Once more, just the same.'

Take off, circle, landing—six minutes of inexpressible bliss. He flew all through August and the beginning of September. Then he loaded his Koktebel and left with Lyushin and Koshits for the Crimea.

Unlike the trials of 1927 and 1928 this rally at Koktebel was called the VI All-Union Glider Championship, and was encouragingly more representative. Applications had come for 22 gliders to take part. The rally lasted from October 6th to 23rd.

At the end of October Sergei, worn out by the protracted strain and sleeplessness, decided to buy a ticket to Odessa and spend a day in his favourite city, wandering about its streets, and return from there to Moscow. The holiday makers had already deserted the Crimea, and there were few people on the steamer *Lenin*. The green sea smoked with

white caps, and in the distance, where the colour of the water matched that of the sky, floated the Crimean coast —rocks alternating with orchards, in whose bright foliage, as if it weren't autumn, the houses were hidden.

He sat on deck and watched the coast. When he started dozing he went down to his cabin, lay down, and fell asleep at once. The unusual quiet and silence woke him, and he sat again on deck. At night the last lights of the Crimea faded behind the stern. And in the morning he wrote to his mother, probably, the longest letter he ever wrote in his life, a letter about Koktebel, about gliders, and about himself.

> 'This year there were many new impressions and feelings at the championship, especially for me. First, our arrival in Feodosia where we met on Thursday, September 24. Then the endless transporting of our machines, hauling them from Feodosia to Uzun-Syrt, the place of our flights. The first two days were a hustle from morning to inky darkness, through which our puffing AMO lorry carried us from Uzun-Syrt to Koktebel. At last the first machine was ready, and the pilot, Sergeev, climbed in and strapped himself in. Words, commands, and he took off in Gamayun. Everybody watched his flight with a glad feeling as he made turns and figures of eight above us all along Uzun-Syrt.
>
> Gamayun passed just overhead, and our commander Com. Ivan Pavlov shouted into the sky, as if he could be heard: 'Well done, Sergeev! You're a real hawk!' Everyone was happily excited; flights had begun. Sergeev landed fastly and smoothly, raced past the tent and put the machine into a steep turn, and then.... Was it a gust of wind or some other reason? But Gamayun instantly shot ten or so metres up, hung above us for a second with wings spread out just like a huge

hawk, and then slipped and crashed with a terrible noise. The fuselage separated from the wings in the air, and broke and folded up like a child's harmonica. In a twinkling there was only a heap of sharp, flat fragments and a light pillar of dust on the hill above which a proud bird had just been soaring.

'Everyone was paralysed, then rushed there, faster, faster! A figure rose unsteadily from the heap, and a sigh of relief swept over everyone. "He's got up, he's alive!" We ran up to him. Sergeev was really alive and even, by some miracle, unhurt. He walked around, swaying and mechanically sorting the bits and pieces out with shaking hands. So everything was all right, and the starting line again began to live its normal working life. New machines were brought up in front of the tents. There are five of us standing in helmets and leather coats in a little separate group and the others surrounded us in a sort of a ring. They stood around us and our red machine which were to take up for the first time. This little blunt-nosed machine rightly deserved the name of the most difficult of all the gliders we had and were now going to try it out.

'We were five, a gliding group that has already been flying together for several years and has now drawn even closer together. Every year before the first flight I feel a strange excitement, and though I am not superstitious this first flight takes on a special significance. At last everything was ready. I buttoned up my coat and climbed in smiling. The familiar faces around responded with smiles, but inside me there was a cold emptiness and awareness. I tried the controls, and looked around. The commands came sharply and quickly. There's only a stream of cold wind in my face. I bank the machine sharply. Far below black points mark the starting point and the

absurd corrugations of the mountains alternate with the squares of ploughed fields. Grand! Fine! Marvellously grand!

'A big red and blue machine has been brought up near the tents. People are fussing around it, and I find it strange myself that I'm its designer, that everything in it, down to the last bolt, has been thought out by me, has been made from nothing, from a piece of ruled white paper. Sergei (Lyushin) apparently feels the same. He comes up to me and says: "You know, it's probably easier to fly than to build." I agree with him now, but I couldn't rid my mind of all my doubts. Was there any thing we'd forgotten, or made wrong or inaccurately? Anyhow, there was no time for wondering. Our good friend climbed into the machine and joked: "Well, designers, now you should worry!" That goes without saying, and we are exerting all our strength to keep calm.

'Later there was a chorus of congratulations, and in the evening at H.Q. I heard our commander (Chief of the Air Force for the Moscow Military Area) combine my role as flyer and engineer into a single, in his opinion, very important whole. I agree with him, by the way. In the morning he issued an order. I am to fly my own machine myself! Everything's going beautifully, even better than I expected, and for the first time in my life it seems I feel a colossal sense of satisfaction and want to shout something into the wind that kisses my face, and makes my red bird tremble, with its gusts... .

'It's hard to believe that such a heavy piece of metal and wood can fly. But it's enough just to leave the ground to feel how the machine becomes alive and flies whistling, answering to the least movement of the controls. Isn't it the greatest satisfaction and reward to fly by oneself in one's own machine?! For

the sake of that one can forget everything, the nights upon nights without sleep, the days spent in slogging work without rest, without respite... . And in the evening... Koktebel. A noisy supper, and if everyone (or rather our group) isn't too tired we go to Pavlovs' cottage to dance and listen to music. This cottage is an oasis where you can recuperate after a year's work and gather strength for the future. But when the moon shines it's very difficult to stay inside even with music. It's better to go down to the shore and climb up on the sharp rocks and listen to the murmuring of the sea. The sea is roaring incessantly, now, too, and rocking our steamer slightly... .

'Now I'm looking forward to Odessa impatiently. For that's where the most golden years of my life have been spent.

'Kisses for you and Greg.
Greetings from Sergei.'

If one ignores Sergeev's first flight—truly you must spoil before you spin well—the rally passed, very successfully. The 1928 altitude record of 375 metres was pushed up by Dmitry Koshits and Andrei Yumashev above fifteen hundred metres! The distance record of 14 kilometres was also exceeded and more than doubled, again by Koshits to 34.6 kilometres.

Sergei Korolev too had every right to feel proud of his achievements. The Soviet journal *Aeroplane* summed up the glider Koktebel as follows:

'The intention of the designers, Lyushin and Korolev, was to build a machine very stable in the longitudinal direction that would not fatigue the pilot in long flights. In this they have been fully successful.'

The man who tested Koktebel, the 'good friend' who, as Korolev wrote to his mother, had advised the young designers to worry, was Konstantin Artseulov*. The description 'good friend' was sheer bravado. Korolev's show of familiarity was just wishful thinking. Artseulov was never his 'friend'. For one thing he was fifteen years older. Korolev was still a student and a tyro in flying, while Artseulov one of the leading pilots and glider-flyers of the time. He had built his first glider back in 1907 and flown at a time when Sergei Korolev hadn't yet learned to walk. He had fought in the World War as a fighter pilot, had been commander of a flying detachment and instructor in the Red Army, and taught over 300 men the art of flying. He was working as a test pilot at one of the biggest aircraft factories in the country and took a passionate interest in aerial photography, which was then a novelty. Artseulov had become famous in 1916 when he, perhaps for the first time in the world, had tested a plane by deliberately putting it into a spin. In short, his fame was no less than that, say, of Nesterov, who first looped the loop. And when he himself (!) approached Lyushin and Korolev and himself (!) offered to test their machine in the air, it was a great honour for them.

'Thank you, Comrade Artseulov!' were the words Sergei said then.

'What for?' queried Artseulov. 'The flight hasn't taken place yet.'

'For trusting in us.'

And when, after the sceptics had whispered 'what if it doesn't take off', Artseulov had taken Koktebel up and

* A grandson of the artist Aivazovsky, Artseulov was himself a painter, which made him a close friend of Maximilian Voloshin. In recent years he has done many illustrations for magazines and books. Years after the glider meetings in Koktebel his old friend Oleg Antonov asked him to illustrate his book *On Wings of Wood and Fabric*, which took them both back to their youth.

then reported to the rally chiefs that the glider responded well to the controls, was well balanced, and suitable for soaring, this was the best reward for Lyushin and Korolev.

But Korolev had good reason to be proud of his achievement as a glider-flyer as well as a designer. The journal *Aviation and Chemistry* published this note from the championship diary.

> 'On October 15th there was great excitement among the record-breakers. The duration record was under three hours, but a young soarer, Korolev in Koktebel, soared for 4 hours 19 minutes.'

The newspaper *Science and Engineering* echoed the magazine.

> 'Speaking of interesting flights we should not fail to mention the conspicuous flight of Com. Korolev on the glider Koktebel, which lasted 4 hours 19 minutes. This flight included some beautiful turns.'

It was those 'beautiful turns,' however, that caused Sergei's friends great anxiety. The trouble was that just when the catapult was stretched to the limit the anchoring screw that held the glider back until the start was torn out of the ground. It was partly the fault of a young glider-flyer and designer Oleg Antonov, future creator of the renowned Anthes. Here's how he recalled Korolev's record-breaking flight in his memoirs:

> 'Unable to hold onto the starting rope and to release it in time I sent the anchor, which got caught in it, up with the glider.
>
> 'Korolev flew for over four hours without suspecting that such a weight was dangling from his tail. But after landing, when he inspected the big hole punched in the tail by that ill-fated anchor, he pro-

mised "next time" to tear my ears, which were red with shame, off with pliers.*'

On his return to Moscow Korolev received the coveted (that he had dreamed as much as his diploma!) sea-green booklet.

'Pilot's Licence

Issued to Com. Korolev S. P. attesting that he has been awarded the rank of a sailplane-pilot, and accordingly is entitled to fly gliders of all types.'

After Gagarin's flight young engineers came to Korolev during his reception hours and asked him to help them set up an air club and gliding section.

'You can't imagine what a wonderful sport it is!' burst out one of them (who knew nothing of this sea-green booklet).

'Well, perhaps I can,' Korolev said with a smile, and reached for a red pencil, blunt from signing papers during the day.

The Sixth Rally was, undoubtedly, a big event in his life. Several months before graduating from Moscow Tech, on the threshold of his engineering career, he had won recognition as a designer and tested himself as a pilot. At last he had heard those words of congratulation and of approval without which the life of any one is hard, however self-assured he is or how convinced that he is right, and without which even a genius staggers.

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* Forty years later Antonov recalled this incident in his book *Ten Times Over Again*. '"What have you got there? Pliers? Throw them at my head! I need them!" That was how I met the designer S. P. Korolev, a man of iron will and boundless humour.'

Paul Richard's design bureau was located in Carpenter Lane in Krasnaya Presnya on the fourth floor of a big building built specially for the store of the famous firm of Moore and Merilies. Later it had become a small factory making air screws and skis for aircraft. After D. P. Grigorovich was removed from the leadership of OPO-3, his place was taken by the designer I. I. Artamonov, but very soon OPO-3 was entrusted to Richard. The Frenchman's Bureau was given the official designation of OPO-4, i.e. the 4th Experimental Section, but was also called MOS VAO for Experimental Naval Aircraft Construction, All-Union Aircraft Corporation.

Richard did not come to the USSR alone. He brought ten of his designers with him, and each one of them apparently hoped very soon to have his own bureau and had already prepared his own projects, sometimes in the form of sketches not supported by calculations. No one was prepared to set up design bureaus for all the Frenchmen, so most of them returned home. Only Richard and the head of the general view section, André Laville, remained in Carpenter Lane. A third Frenchman, Auger, manager of the loft floor was down in the Fili factory which gradually lost its former independence and became Richard's production base.

The design bureau worked to a plan confirmed by Aviatrust. It was a very broad plan and included around ten hydroplanes for various purposes: a two-seater fighter, a torpedo-bomber, a close-range naval reconnaissance plane, etc. But it soon became clear that an attempt to kill two birds with one stone would spoil the sport. And then Grigorovich's recent unhappy experience was fresh in everybody's minds. Gradually the main forces of the design bureau were concentrated on one plane, the TOM-1 (an open-sea torpedo-bomber).

Thus, toward the close of 1929, when Korolev had retur-

ned from Odessa, work on the TOM-1 was in full swing. At the time such famous aviation engineers as I. I. Artamonov, D. M. Khomsky, P. D. Samsonov, I. V. Ostoslavsky, M. P. Mogilevsky, A. L. Gimmelfarb, and V. B. Shavrov were working there. The brilliant Soviet aircraft designers S. A. Lavochkin, N. I. Kamov, G. M. Beriev, and M. I. Gurevich began their careers with Richard. Carpenter Lane also united the two friends, Sergei Lyushin and Sergei Korolev. Lavochkin was then working on strength, Lyushin on the wing and controls, and Korolev on the armament, the arrangement of the machine-guns and the design of the gun turrets (the TOM-1 was armed with three machine-guns).

Work in the bureau was complicated by the rather strained relations that existed between Richard and Laville. Richard was casual, hot-tempered, and high-handed. Though he worked in the USSR for several years he didn't learn to speak Russian and didn't think it was necessary to learn. Laville, on the other hand, was a very amiable, open-hearted man and a most talented engineer, which he soon proved by his work. Although most of the engineers in the bureau were able to make themselves understood French, even if they could not speak it fluently (they exchanged French phrases even among themselves), Laville learned Russian, his mistakes and wrong stress only amusing his Russian colleagues and creating a feeling of greater sympathy with him. So naturally he became a more popular figure than Richard, who disapproved of his compatriot because of the latter's excessive democratic attitude.

The TOM-1 project, completed in July 1929, earned no glory for Richard, for he was late with it. And his torpedo-bomber was very like a naval version of Tupolev's TB-1 heavy bomber. The TB-1 had already gone into production, and the TOM-1 was technologically more complicated. For instance, it had twice as many rivets as Tupolev's plane. The whole project did not get beyond the production of

an experimental prototype, which was later test-flown at Sevastopol. When it became clear that the plane would not go into serial production Richard went back to France. (Laville stayed on in the USSR. In the summer of 1930, together with Lavochkin, Kamennomostsky, Felsner and Lyushin, he left the design bureau and set up his own small, but highly compact group, which became known as the BNC—the Bureau of New Constructions—and lasted for some three years. Later Laville worked at the Civil Aviation Research Institute or NII GVF, and in 1935 left aviation to become Moscow correspondent of French newspapers, returning to Paris only in 1939.)

Years later, in the sixties, a leading Soviet aircraft designer met his former *chef* at Le Bourget Airport while on a visit to the French air saloon. Richard had altered greatly and looked aged. Both recalled Carpenter Lane, and their youth, and their old acquaintances with usual sighs 'some are no more, and others far away'.

'And Sergei Korolev? How is he? Do you ever meet him?' Richard asked. 'I've heard it said that our Seryozha is now a designer of space rockets!'

After Lyushin left with Laville Korolev continued for some time working under Richard. People who knew him in those years maintain that he showed no outstanding qualities in the design bureau, was not a 'fountain of ideas', but behaved quietly and modestly, and that his attitude toward his job, if not quite formal, lacked enthusiasm. That may easily be explained, first by his general inclinations as an engineer, and second by his personal preoccupations at the time. In all his work Korolev had always an inclination for generalization in engineering, for technical synthesis. He was always attracted, if put it like that, by ultimate designs, a glider, an aeroplane, a rocket, but never by the wing of a glider, by the controls of a plane, or the

nozzle of a rocket. In two years he would realize that the fulfilment of all his plans was hampered by lack of a reliable rocket motor but, while asserting that, he was not himself going to work on the motor because it was only a part of the whole. It was impossible for him to show great interest in a machine-gun placed in a retractable turret in front of the rear turret of the TOM-1, because he was engaged at the same time in building two aircraft of his own, the SK-3 glider and the SK-4 light plane.

'As soon as we got back to Moscow from Koktebel in the autumn of 1929 Sergei suggested that we build a glider for stunt flying,' Lyushin recalls. 'A variety of reasons prevented me from taking it on. So he began designing alone what later became the SK-3 (Red Star)*.

Even a man with Korolev's capacity for work could not design and build the projected glider in a year (for, of course, it had to be at Koktebel in the autumn of 1930), and that was clear to Sergei. So he looked around for helpers. The first one was his stepfather.

After Sergei had come to Moscow from Kiev his relations with Balanin had grown more friendly. His boyish prickliness, when any advice or comment was regarded almost as an insult, was past. The boy had become a man, had learned to know people, and had cultivated the tolerance without humiliation that is indispensable in collective work. On his side, Balanin had dropped his misgivings about Sergei's future.

Now he was convinced that Grain Harbour and its hydroplanes and the naive projects of the Anatra villa had not been a whim, not just boyish fancy, but real dedication. And last but not least, the gentle tenderness and tact of Maria Balanina, who loved her second husband and her son dearly, had also been instrumental in bringing about

* Named in honour of the Army newspaper *Krasnaya Zvezda* (Red Star).

a thaw in their relations. The ice had not fully melted yet, but was in the course of doing so.

Sergei and his stepfather spent many an evening with slide-rules in their hands making the calculation for the new glider. Their fingers moved so quickly that the slides actually grew warm. They spoke little; everything was clear without words. But if they did begin to talk, it went on for a long time; then the pages of handbooks were feverishly turned, formulae were underlined with vigorous fingernails, and sharp pencils broken in hasty proofs.

What had Korolev thought now? The Koktebel that he had built with Lyushin was a simple sailplane. Its design, though unquestionably original, still complied with commonly accepted practice. The task he had set himself now was much more complicated. Here is how he himself described it:

> 'Our purpose was a single-seater flying apparatus that will enable the figures of aerobatics to be performed. Among these, in particular, looping the loop presented special interest.
>
> 'The aim of building such a machine was to prove that it was possible in general to perform the figures of aerobatics in a glider. The sole experiment in this direction had been made in America, but the pilot José, who made four loops, utilized an aeroplane to tow his glider and help him gain height. So we were posing such a task for the first time for a glider-sail plane that would gain height unassisted.'

Then followed an extremely interesting technical argumentation in favour of this particular glider, and no other, characteristic of Korolev:

> 'Further, a glider for stunt flying, possessing great reserves of strength adequate "for all contingencies", presents opportunities of using it to measure the stres-

ses developing in flight and to carry out all kinds of observations impossible with a glider of the normal type.'

That is to say, it was a matter not only of a new flying machine, but also of a new *tool* for research. The train of thought was absolutely logical: Red Star was not simply to perform sensational aerobatics and loops never seen before, but much more important was to provide information that would enable the next, even bolder, step to be taken. In spite of all his youthful vanity Korolev rejected sensation in advance in favour of testing his engineering ideas. But his vanity made him, at the same time, meet possible reproaches that the design was a compilation. He was modest, but he argued in advance:

'... such a glider, possessing together with great strength flying qualities that will enable it to soar even in a quite strong wind, even though it does not pretend to possess any special record-breaking qualities, is still something new as a design.'

On Khodynka Field Korolev encountered Pyotr Flyorov.

'I'm building a glider for aerobatics. Come and help.'

'It's impossible,' objected Pyotr. 'A sailplane must be light, and stunting with its loads require additional strength, and that means extra weight.'

'It is possible. Greg and I have calculated it. It turned out to be possible. So, will you come?'

'What to do?'

'Choose—wings or controls.'

The wing was boring; and Flyorov knew nothing about controls.

'O.K.,' he said, 'I'll do the controls.'

It was impossible to refuse. When he and Igor Rosanov had been designing their light aeroplane who was the first

to help them? Korolev. And then he simply liked working with Sergei. It was quick, clear, gay work. True, when strangers were around Korolev sometimes put on airs and played the boss. And Pyotr didn't like that.

'When shall I come?'

'Today, of course.'

In addition to his true friend Flyorov, Korolev drew many others into work on his glider. Every evening two or three people would be working in his home. The most frequent visitors were Nikolai Yuriev, an engineer from the aircraft factory, Pavel Ivensen from the light-engine aircraft committee, Evgeny Matysik, a young glider-flyer who had been introduced to him by Gribovsky in the Crimea, and Pavel Semyonov, who had helped when they were making the blueprints for Koktebel. Some of the helpers came to his home design bureau quite regularly, others put in an appearance and disappeared, but he didn't hold it against them; the main thing was that the work was going ahead. But all these helpers only turned up after Osoaviakhim had approved the aerodynamic and weight analysis of the glider. Only then did Korolev receive the money for making the blueprints and for building it. The people at Osoaviakhim were experienced customers.

'You say aerobatics? Well, will your glider stand up to prolonged diving?'

Korolev had been expecting that question. The moment on the wing will really be very great, but it could be compensated. 'Here, if you please,' and he presented the analysis.

When conversation turned again to where it was to be built and who was to do it, Korolev by habit went straight to Begovaya Street. Soon work in the horse-shelter was in full swing; there were now two benches, a fitter's and a carpenter's, and a hand drill. Everything went well until the foreman Murashov, an extra-class joiner, got drunk. Korolev blew up and sacked him.

'We'll get on without him,' he told Matysik.

It was difficult without Murashov, but they managed. Unintentionally coping his aviation tutor Dmitry Koshits in little things, Korolev bought himself a motor-cycle and joined the Avtodor automobile association. That summer his black and green Derad sidecar-combination (Koshits, of course, rode Harley-Davidson) was a great help. He rode it to work, and then to the workshop, and to the warehouses, loaded it with the parts of metal elements, plywood, various details and materials. But it wasn't always possible to get the right materials.

'The extremely short time (47 days) and the far from brilliant conditions in which we were building,' he wrote, 'from the outset set limits the designer did not dare exceed. Such objective reasons, of course, contributed little to the excellence of the design. The static tests planned could not be carried out. Only the connections joining the main planes to the central section were tested to failure.'

From Begovaya St. where the SK-3 was being built, Korolev would race to Khodynka Field; the lessons still went on at the flying school.

It had now begun to look like a school. Several French Henriots trainer biplanes had come to the rescue of the unhappy *Avrushka*. Korolev was now flying solo without an instructor, and each time the tasks set became more and more complicated. On one occasion he was to climb to 3 000 metres. He took off, but not knowing the scale of the barograph climbed as high as 5 400 metres instead of 3 000. He would have climbed higher, if the engine had not stalled. The plane went into a glide. Korolev saw it would be difficult to land in Moscow and headed toward the suburbs looking for a suitable field. It was a calm summer evening, and everything went smoothly as in Koktebel. He relaxed. 'But what's the matter with the engine?' He touched a wire leading to the ignition, and suddenly the engine started!

Korolev passed out from the flying school in the summer

of 1930, receiving a pilot's licence of which he was very proud all his life.

When Red Star was ready it was put before the technical committee. The chief examiner was S. V. Ilyushin, whose standing as a designer was already very high. He was sombre and stern, and bore himself very officially. He did not look at the blueprints, but inspected the glider from all sides, tried the controls, and ordered a roller to be changed. The roller was changed that day, and Ilyushin gave his 'O.K.'.

Korolev could not wait to test the glider in the air. On their rest day he and Flyorov and the riggers took the SK-3 to the Glider Station where many glider-flyers were now training. It was a warm, clear, perfectly calm August day. Despite all their attempts they could not get Red Star into the air. Korolev was disappointed, but did not show it.

'There's no wind,' he said to Pyotr. 'I'll take off in a wind. In the Crimea. Take her apart.'

Simultaneously with building the glider Korolev was working on a plane. When he defended his diploma project his light plane existed only on paper, but his attitude toward the job was not formal. He no longer needed the little plane for his degree, but for himself. He had set himself the task of making a 'long-range' baby plane, planning flights in which the SK-4 would be air-borne for up to 12 hours. Its construction was also being completed on Begovaya St. in an old church not far from the tethering post. Korolev scoured Moscow on his Derad in search of parts and materials. The success of a constructor depended largely on his skill as a supply agent, on his ability to combine 'legal' methods of procurement with 'semi-legal' ones. The official organization to which he could turn for assistance was the light-engined aircraft committee of the Central Council of Osoaviakhim. Pavel Ivensen had been elected secretary of the committee, Korolev's kind of fellow, a glider-flyer, whom he had met in Koktebel. During the

work on the blueprints for Red Star, Ivensen was not able to be of special help; everyone was building something and they all needed help: Yakovlev was building a biplane, Raphaelyants a monoplane, Skrzhinsky and Kamov an autogyro, and they were all asking for help. Korolev spent much time in particular looking for an engine. He needed one of 100 horse-power. He poked about in every aviation corner and hole, but, alas, found none, and had to be content with a 60-h.p. Walter.

'Install this for the time being,' he told the mechanics invited from Fili, 'then we'll see. If I'm able to get a more powerful one we'll change it.'

And just as construction of the glider was being completed, and work on the SK-4 was in full swing in the church, Korolev disappeared. Without telling anyone he bought a ticket, boarded a train, and left for the Donbas. Left for Lyalya.

Lyalya Vincentini finished the Kharkov Medical Institute in the spring of 1930. During the years since they had talked on the Commercial Stairs Lyalya had come to Moscow several times alone or with her brother Yuri. In 1926 Sergei had gone to Kharkov for May Day. The next year he had gone with the Vincentini family to the Crimea. And he frequently telephoned from Moscow. All Lyalya's friends at the Medical Institute knew she had a 'Sergei' in Moscow who was a famous glider-flyer, pilot, and engineer. Korolev felt that his old rivals Nazarkovsky and Kalashnikov had been defeated, but Lyalya was not in a hurry to get married, and this enraged him. Tormented by groundless jealousy he had rushed off again to clear up their relations.

Lyalya dreamed of becoming a surgeon, but in Alchevsk where she was sent after graduation they had decided otherwise; she became a general practitioner, then manager of the district hygiene centre, then a deputy inspector in the

district health department. There was not even a smell of a surgery.

Sergei found her in the hostel for the engineers and technicians of the steelworks, where she and her friend Vera Kalugina were living. He stayed in Alchevsk for several days. Lyalya was at work all the time, and was dropping from fatigue; dysentery and typhoid fever were rampant in the region. On one occasion she said to him:

'Would you like to go down a mine with me?'

Sergei consented immediately, of course. They went down like the wind in a tub cage. Then walked for a long time in almost total darkness. Drops of cold water dripped down his collar. Somewhere far ahead something was making a loud metallic rattle. Lyalya showed him her underground first aid post. Sergei didn't like it in the mine. 'It's better up top,' he said.

That evening Vera Kalugina at last had the sense to go out to a friend's, and leave them alone together. Lyalya said that she was willing to marry him.

Before leaving for Koktebel Sergei very much wanted to take his light plane up once, and he hustled the mechanics. Red Star had already been sent off to the Crimea when the brand new SK-4, grey with a red stripe along the fuselage, was brought to the airfield. Using a drill with a felt polisher they buffed the cowling to make it shine. It was a feast for the eyes, not a machine. As chief mechanic, Flyorov gave the signal to start. Korolev climbed into the front seat clad from head to foot in crackling leather, with goggles on his forehead. He was terse, very aloof, and behaved so as if he was about to fly to America, not to circle the aerodrome. Behind him was Dmitry Koshits. Properly speaking, he was going to fly the plane, but Korolev could not let the maiden flight of his first plane take place without him.

The starters at the edge of the field waved the white flag.

'That's for us, I suppose,' Koshits said. 'Let's go.'

The plane took a very long time running across the field, like an overloaded bomber, and Flyorov was thinking it was not going to take off at all. From the sound of the engine it was clearly not full out. The screw was apparently too heavy. At last they took off. Circled, then circled again, and landed. They levelled out a little too high, it seems, and flopped a little. The axle was bent. But that was a trifle. The main thing was that the machine had flown! Sergei was jubilant.

'She flies superbly. We'll have to put on a smaller screw. So, get on with the repairs and fly, but we're off to the Crimea. It's time!' he said to Flyorov.

The flight of the little plane did not pass unnoticed. The newspaper *Red Star* wrote about the SK-4:

> 'The plane has already made its first test flights piloted by Koshits and the constructor himself.... It displayed very fine flying qualities.'

After Korolev's departure the SK-4 was repaired and Igor Sitnikov flew it several times during the autumn.

For the ease with which Korolev had managed to find the hours and days for his trip to the Donbass, and for the construction of his plane and glider, there were several objective reasons, apart his own talents. Experimental aircraft construction was in the throes of a new reorganization. And every time far-reaching measures are taken to intensify work things are brought to a complete stand-still, for a while. Nothing is so favourable to idleness as reorganization.

The Menzhinsky Central Design Bureau was organized on the basis of the Aviation Worker factory. Two designers from the Central Bureau, Polikarpov and Grigorovich, were transferred to it. Polikarpov was put in charge of work on the general lines and fuselage, Kostkin was in charge of

the wings, Sedelnikov of the under-carriage, Nedashkevich of the armament, while Goncharov was responsible for the aerodynamic calculations. Each of them was in charge of dozens of people. The CDB grew by leaps and bounds. Toward the close of 1930 three hundred people were already working there, a year later 500, mainly engineers from Polikarpov's and Richard's bureau. The CDB was headed by A. G. Goryanov, chief of the technical department of the OGPU. The director of the factory was N. E. Paufler, also from the OGPU. There was no chief constructor. Grigorovich, who was more or less doing this job, had the title of consultant, the decision-making body was the technical council of the Bureau.

This transfer of a big group of engineers from Richard to the CDB (only few designers remained with the Frenchman who were putting the finishing touches to the TOM project) took place in the summer of 1930 when Korolev was racing around Moscow on his Derad. While everybody was settling down, finding his place and getting down to business, he was building his glider and light plane. By the time of his departure for Koktebel, however, things had been sorted up. Korolev was working with the engine group. Grigorovich put forward the layout and general lines of a new heavy bomber, the TB-5, and the whole of the Central Bureau was gradually involved in it as the main thing.

From Feodosia they rode on the Harley-Davidson which Koshits had taken with him to the Crimea. Sergei was driving. They sped past mazharas and gliders; the rally promised to be a big one. Applications had been sent in from 18 organizations. The sight of Koktebel made Sergei's heart beat quicker. He now felt a great love for this place. How much more beautiful it was than well-groomed Alupka!

Hullo, Uzun-Syrt!

It seemed, as if nothing had changed here in the past year. The sides of the hangar marques fluttered in the wind as before. The same lean horses dragged the gliders uphill.

The rose muscat in the cellar of the Greek Sinoplos was just as cool, and the grin of his wife, with whom they boarded, was as wide as ever, and her cook, who in days gone by had prepared meals on the Czar's yacht *Standard*, and who invariably retorted to all culinary remarks addressed to him with the stock phrase 'His Imperial Majesty didn't complain' was just as haughty. Everything was exactly as last year. Yet now everything was different —the people, and the mountain, and the sea. Everything was different because this time he had his own glider, without a co-author, his sailplane, his SK-3. And because he was going to watch it fly here, on this very mountain, and to fly it himself, absolutely!

The presentation to the technical commission was a mere formality. For you could see how well-built it was—a most elegant glider! A mulberry beauty! Where was there one that could stand comparison with it? No, to be objective, Antonov's Standard was good, Ilyushin considered it the best glider at the meeting. Antonov was a talented constructor. And a good chap. They had met last year when Sergei flew with the anchor on his tail. Of course, the Scythian that Tikhonravov, Vakhmistrov and Dubrovin had brought with them, or the Gryphon of Zhemchuzhin, Tomashevich and Sorochinsky were classical sailplanes and excellent machines, no doubt about it, but what would happen if you tried aerobatics with them. The wings would fall off immediately.... Even his and Lyushin's Koktebel, with a new tail and fin to strengthen the rudder and elevator, even old Koktebel couldn't do it. *Airforce News* had every reason to write, even before the rally took place:

> 'As an interesting newcomer we can note the glider of Com. Korolev's construction, intended specially for aerobatics.'

He had reached agreement on a display of aerobatics with Vasily Stepanchonok earlier in Moscow. The latter had not

required much persuasion; he himself was very anxious to loop the loop in a glider. Last year in Kacha he had tried something like it; he had gone into a loop in *Avrushka* with the engine cut out. True, *Avrushka* was not a glider. It could reach a speed of some 160 kilometres per hour without falling to bits. Stepanchonok had faith in Korolev and his Red Star. Moreover, N. E. Zhukovsky, and V. N. Pyshnov after him, had theoretically proved that a glider could loop the loop. Back in Moscow Stepanchonok had made up his mind to have a go.

As a concession to Korolev, Stepanchonok let the author of the design make the first flights on Red Star. Korolev flew her four times, but the flights didn't last long; the glider didn't soar as well as he had expected. It became clear that modifications would have to be made to the rudder compensator. When the rudder was ready the weather became bad. Low clouds enveloped the Uzun-Syrt, a strong wind flew off the sea, and it rained. Sergei was in low spirits, and he didn't feel well; his head split with pain and he was feverish. He realized he was falling ill.

'Go to Feodosia,' Stepanchonok advised. 'Let them give you some pills.'

'But if the weather improves...'

'It won't. I know the Crimea. It'll last for several days.'

Sergei went to Feodosia and didn't come back. He was put into hospital. It was not a cold. This was typhoid fever. The epidemic Lyalya had told him about in Alchevsk had caught him in the Crimea at a most inappropriate time. As if an epidemic could be timely?

But the flight he had awaited with such impatience took place nevertheless. This is how Stepanchonok, the hero of the day, described it:

> 'It was already clear in the morning that the day promised to be windy.... To let candidates to take off from the southern slope in such a wind to pass exami-

nation for a gliding licence would have meant taking risks. Half-an-hour later it had already reached a speed of 13 or 14 metres per second. Red Star had been brought over from the Northern slope and stood ready at the start. I took a good look round for the last time before the flight... . I took off cautiously at high speed and flew to the end of the mountain. A smooth turn, and the glider returned to the start. My altitude was around 200 metres above the slope. I could see a group standing near the ground strip, watching, the other glider pilots... . I turned the glider toward the valley and increased the gliding angle. The wind blew stronger in my face... . Now carefully, a last movement of the elevator, and I saw the earth rushing at me and the hamlet of the village of Barakol growing rapidly in size... . "How much height had I lost?" was my instant thought. The earth seemed so close. Gently and slowly, I reduced the pressure on the stick and the glider nosed up, ploughing the sky.... Now she was in an almost vertical position. Without hurrying I moved the stick more quickly... . I was rolling over on my back... . Should I hang there or not? No, there was some speed left yet, the straps on my shoulders weren't pulling. The stick was as far as it would go and... silence... . Not a sound... . As quiet as in a calm.

'The southern side of Uzun-Syrt rushed past; a few moments more— and the glider was already calmly continuing normal flight. I flew again in the direction of the slope, climbed again near the start, where the group of flyers was standing motionless, faces turned up. A signal—attention... . I signalled that I was going into a second loop.... . And the thought ran through my head: "Poor Seryozha has no idea of what's going on."'

[The constructor was lying in bed in Feodosia hos-

pital at the time, exhausted and weakened by typhoid fever, torn away from his glider and the rally, quite helpless.]

'After the third loop I saw a bustle down at the starting point... . Someone was hurrying with a piece of plywood to the flagstaff. "They're laying out an order to land," it flashed into my mind. "Poor Rosanov*, I suppose, he's very worried." I landed only a few dozen strides away from the take-off point. Much esteemed Artseulov came running up full tilt. And Burche with a smile splitting his face... . And after him the rest.'

The dreams of the designer and pilot had come true. The loops executed by Stepanchonok were the sensation of the seventh rally. Ilyushin has stressed the importance of Korolev's design for applied science:

'The loops made by pilot Stepanchonok V. A. on the SK-3 glider deserve recognition as this year's great achievement. The glider is very important from the point of view of introducing aerobatics into the training programme of glider flying and also of equipping gliders with instruments, assessing their qualities and taking the glider's drag polar.'

The *Air Force News* also wrote about the possibility of 'taking the first step toward the type of training glider for aerobatics and getting a machine possessing such reserves of strength as to enable the critical values of overloads to be tested in practice'.

In short Red Star made its young designer famous. Of course, Korolev justly shared this fame with the pilot. Sergei rightly described Stepanchonok's flight as 'exceptional in its boldness and beauty'.

* A. M. Rosanov was Chief of staff of the Seventh All-Union Glider Rally.

Stepanchonok was, indeed, a very gifted pilot and glider-flyer. All his future work in aviation justified the tributes he earned that autumn in Koktebel. The famous test pilot, P. M. Stefanovsky, who was in contact with him for many years, listed in his memoirs the qualities that later made it possible for Stepanchonok to become an excellent test pilot: 'Immaculate technique in piloting planes and gliders, an inexhaustible passion for flying, and a vast love for aviation.'

Stepanchonok was killed in 1943 testing a version of the ill-starred plane in which Valery Chkalov and Thomas Suzi had lost their lives.

Stepanchonok looped the loop, but the designer lay in hospital in a very bad state. A cold wind whistled through cracks in the window. Next to him a dying Georgian groaned faintly. Sergei suddenly felt desperately lonely and deserted. He dictated a telegram to Pyotr Flyorov to the nurse: 'Ill with typhoid fever Feodosia stop Everything at your discretion stop Sergei'.

Pyotr ran to Alexandrovskaya St. with the telegram. Two days later Sergei's mother came to Feodosia. He tried to put on a bold face, but it didn't come off very well. Maria Balanina was afraid he would catch cold in the ward and persuaded the doctors to discharge her son from the hospital. For several days he lay in a room at the Astoria, a typical old seaside hotel, built for marital infidelity. After the typhoid there was a complication, inflammation of the middle ear. This called for an operation, but the local doctor admitted that he was afraid to perform it. So they went to Moscow. Not only his ear, but his whole head was racked with pain; the skull swelled painfully and the only thing he wanted was to rest his forehead against cold glass and fall asleep.

When Sergei was admitted to the 2nd University Clinic

he was in a very bad way, trembling all over with fever. He was put near the stove. Igor Rosanov, an old Tech friend whom Korolev had helped build a glider, asked his father, an eminent doctor to help Sergei. Prof. Rosanov telephoned to Prof. Sverzhevsky, and the next day Sverzhevsky operated on Korolev. Trepaning of the skull is a rather unpleasant business. Korolev was in the hospital a long time. Flyorov and Igor Rosanov occasionally came to visit him. Sergei would ask about the light plane and about affairs at the design bureau; Flyorov, too, was now working at the CDB with the under-carriage group. Sergei would nod his bandaged head and having heard all the news would start 'giving orders'.

'Pyotr, we must check the collector tank of the SK-4; see that it doesn't draw air from the big tanks. And you'll have to get the skis from an Henriot somewhere. I've a mind to get out of here, and we can't fly without the skis.... .'

Flyorov, of course, found the skis but they were not needed. Sergei, although discharged from the hospital, felt very poorly. He stayed at home and read a lot.

The Ninth Congress of the Young Communist League opened in the Hall of Columns. On January 25th it decided to become patron of the Air Force. That was grand! In his speech at the Congress, the People's Commissar of Defence, K. E. Voroshilov, quoted the German general Lüdendorf, who had written that he set the date for a new war as 1 May 1932. The day, Lüdendorf had said, would be set a few weeks before the harvest and that for the nations that would be destroyed it made absolutely no difference whether the war started in 1931, 1932, or 1933. Korolev remembered those words in the summer of 1941, 'several weeks before the harvest', as a crowded, badly-lit, stove-heated goods van carried him east to Omsk.

Now Korolev received a temporary disability pension, for his sick leave had run out. As he had no money, he sold his Derad to Pyotr. And Pyotr, too, was down in his luck;

he broke his arm and was also at home. It was the dreariest winter of Korolev's life. Some were harder, but none so depressing and idle.

He returned to the Central Design Bureau as work on the TB-5 was ending. The schedule was very tight and they were working late. This bomber was regarded as trumps; the prestige of the whole staff had been staken on this card. Grigorovich knew that success in this new project would help restore his good name and that of his colleagues, and redeem their honour as engineers and patriots. He spent hours on end studying the drawings, leaning on the table his huge athletically-built body. He had a marvellous, supernatural feel for mistakes in drawings, as if a magnet drew his red pencil to them. He was rarely to be seen in his office, more often he took his stand beside some designer. They all, engine men, under-carriage men and armament men, worked in one big loft that occupied a whole floor of the building, and Korolev was frequently able to watch the Chief constructor (*de facto* if not *de jure*) in action. Grigorovich was very strict and demanding, but it was evident that he took his work much more to heart than anybody else, and that left people no moral right for grudges and reproaches.

The maiden flight of the TB-5 took place in May 1931. It was piloted by Buchholz, who was the Bureau's Chief Pilot. Voroshilov, the People's Commissar, and a host of high-ranking officers were present at the airfield.

'I consider the plane a masterpiece of world aviation,' Buchholz said when Voroshilov asked him about the bomber, looking the People's Commissar straight in the eyes without blinking.

He did the right thing, of course, in saying so, but the TB-5 was not a masterpiece. It soon became apparent that the very feature that Grigorovich regarded as the advantage

of his machine—the rejection of all-metal construction—was its shortcoming. The design parameters of the TB-5, which was already flying, were inferior to those of Tupolev's TB-3 which was still on the drawing board. And when the TB-3 took the air at the end of 1931 it became clear that this was going to go into serial production. Just the same Buchholz did well to call the TB-5 a masterpiece: the good names of Grigorovich and his comrades were restored.

Apart from the major trials of the TB-5 which were widely discussed at the Central Bureau small-scale trials of the SK-4, about which only a few knew, were also taking place.

In March Korolev called in mechanics to repair his plane and prepare it for flights. The skis were again replaced by wheels and the paintwork touched up, bearings oiled and the engine tuned. All in all, everything looked well, but still the plane didn't want to fly; things kept going wrong, the insulation of some leads failed, leaks developed, too much play was detected in parts, and so on without end. Much later Korolev understood that the hastily built SK-4 was a classic example of a raw design. It was probably the only one of his designs that Korolev lost patience with.

Still, Koshits made several flights in the plane. The newspaper *Evening Moscow* even published a report of them:

> 'At the end of last year the well-known engineer S. P. Korolev, author of the glider Red Star in which last year in the Crimea Com. Stepanchonok was the first to loop the loop, has designed a new type of a light two-seater plane, the SK-4. The pilot, Com. Koshits, has already made several test flights in this plane which demonstrated its fine qualities.

But, despite its 'fine qualities' the SK-4's engine stalled during one of these flights when the plane was near the airfield. Its altitude was so low that Koshits could not reach the field and crashed on the roof of a hangar.

An anonymous photographer recorded the sad picture; the smashed plane, two gloomy members of Osoaviakhim, Koshits ill at ease with a scratch on his cheek, and next to him, Korolev in a white shirt, tie and an elegant, light-coloured mackintosh. And even a sort of smile on his face.

It was probably with a smile of that sort that he composed the following ditty:

By the broken tub
The family held a session;
Koshits had a broken mug
And] me had a silly grin

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It was certainly not the time for smiles, and Korolev was, of course, upset by the end of his little plane. But it could not be helped now. He had many new plans in his head. And in conversations with friends the words 'rocket' and 'rocket motor' could be heard more and more frequently. It was not something new. Few had not heard about rockets and something had been written somewhere about engines, too. Yes, everybody knew about them. But it is impossible to understand why this particular 24-year-old glider enthusiast, this young designer in an aviation constructors' bureau, should suddenly turn, like a traveller in the night, toward the beacon of the rocket. And it is impossible to explain how he saw its great future in the dark distance of the times and immediately believed in it, or how he detected the barely audible whisper in which his fate spoke to him.

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CHAPTER 15

A TASS commentator, A. P. Romanov, wrote the following account of an interview he had with Korolev in November 1963:

> 'One of the brightest recollections of my life was my meeting with Tsiolkovsky. I was twenty-three at the

time. It was in 1929. We arrived in Kaluga in the morning, and we met him in the wooden house where he then lived. We were greeted by a tall old man in a dark suit. During conversation he would put an ear-trumpet to his ear, but begged us not to speak loudly. I remember his marvellously clear eyes. His face was creased with large wrinkles. He spoke vigorously and emphatically.

'The talk was not a long one, but was circumstantial; in thirty minutes or so he gave us the gist of his views. I cannot vouch for my accuracy, but one phrase stuck in my memory. When I declared with fervour of youth that my aim from now on was to reach the stars, Tsiolkovsky smiled. "That's a very difficult business, young man, believe an old man like me. It requires knowledge, persistence, will power, and many years, perhaps a whole lifetime. Begin by reading all my papers. You should know them to begin with, anyway. Read them with a pencil in your hand. I'm always ready to help you."

'Tsiolkovsky impressed us then by his faith in the possibility of cosmonautics. I left him with one thought—to build rockets and fly them.'

In A. P. Astashenkov's book *Academician S. P. Korolev* we read:

'In 1930-1, during a period of intensive creative effort, study, and flying, Korolev became acquainted with the ideas of K. E. Tsiolkovsky on reaction propulsion and cosmonautics... . He settled down to study Tsiolkovsky's works... . And study of them led him to the conclusion that great ideas of the Kaluga dreamer, which seemed fantastic to most people, were realizable. And that the time for it was not so remote.'

But did Korolev go to Kaluga or not? The answer to question may not seem important to the reader, but when one

traces the life of a man month by month, year by year, everything is important. And then there's the simple interest of the thing. I was eager to find out. One of the people of the Kaluga Cosmonautics Museum gave me the address of a lecturer at the Tula Polytechnical Institute, B. G. Teterkin, who, he said, had seen Korolev in Kaluga. In reply to a letter, B. G. Teterkin told me that Korolev had visited Kaluga in the autumn of 1929. He wrote further that he had met Korolev in the afternoon of the day on his way to Tsiolkovsky's house. They went together and left together. The conversation, as far as B. G. Teterkin could remember, centred around gliders and the possibility of using rocket motors in aviation. Later Korolev went home with Teterkin and waited there for his train, it being cold outside. He left at dusk.

Tsiolkovsky's meetings with Korolev in Moscow are well known. But what about Kaluga?

Yu. V. Biryukov, a biographer of Korolev working at the Institute for the History of Natural Sciences and Engineering of the USSR Academy of Sciences has also not succeeded in finding anything about the Kaluga meeting. No traces of it are preserved in the archives of the Academy of Sciences, or in Korolev's papers, or in Tsiolkovsky's papers. Finally, Korolev's mother does not remember his going to Kaluga. At home he talked about Tsiolkovsky's books, and it was clear that their ideas interested him, but he never said anything about a trip to Kaluga, or about meeting Tsiolkovsky in person.

Careful analysis of the information confirming a visit to Tsiolkovsky in Kaluga quite quickly brings out several discrepancies. Romanov writes that, according to Korolev himself, he arrived in Kaluga in the morning and was not alone. In his story he always said 'we', 'we met', 'he greeted us', 'he told us', though he does not name his companions, or companion. Could it have been B. G. Teterkin? But Teterkin lived in Kaluga and therefore had not

arrived from anywhere. Moreover, according to him, he met Korolev in the street and not in the morning, but in the afternoon. Teterkin remembers Korolev being alone. So where did the 'we arrived' come from?

There are not only inconsistencies about the time of day. Teterkin stresses that the weather was bad, and cold, and that the affair happened in the autumn. But in the autumn of 1929 Korolev was in the Crimea.

There are also discrepancies on the subject of the conversation between Korolev and Tsiolkovsky. According to Romanov, Korolev told Tsiolkovsky that his aim was to 'reach the stars'. Teterkin's theme is more probable for it would have been of interest to Korolev at that time whether it was possible to use a rocket engine in gliders and aeroplanes.

Tsiolkovsky, who helped rocket enthusiasts greatly with his letters to meet each other and always advised them to get together, nowhere quotes Korolev and when he does mention his name never mentions that they were acquainted.

True, Korolev was an enthusiastic beginner then, a young, inexperienced man, just a boy to Tsiolkovsky. But why Korolev himself does not recall the Kaluga meeting in any of his papers? He didn't speak about it even in his speech at the ceremonies in honour of the centenary in 1957 of Tsiolkovsky's birth, although a better occasion could hardly have been found.

I should think that the Kaluga meeting of 1929 itself is only of theoretical interest. In a short interview with Tsiolkovsky Korolev could hardly have discussed all the problems of the development in rocket engineering of interest to him. Much more important is the fact that Korolev was concerned with these problems then, that he already knew Tsiolkovsky's works, that he was thinking about them and looking for ways to implement them in practice.

When Korolev explained his interest in rocket technology solely by acquaintance with the ideas of Tsiolkovsky and the plans of Zander, that, as the mathematicians say, is only a first approximation. There were many factors that affected the development of this interest in one degree or another.

The aim of our chronicle is to tell about the life of one man and not to give a history of rocket construction and cosmonautics. But a brief historical survey is quite necessary in order to understand the state of rocket engineering when Korolev entered this field and in order to marvel how harmoniously his personal aspirations matched the needs of the age.

Tsiolkovsky published the first part of his paper 'The Study of Universal Space by Means of Rocket Apparatus' in the *Scientific Review* in 1903, before Korolev was born. This work, the importance of which for the progress of mankind can be likened to that of Nickolas Copernicus' *De Revolutionibus* or of Isaac Newton's *Principia*, at the time was not remarked or valued. At the end of the nineteenth century and beginning of the twentieth only rare enthusiasts devoted their energies to the rockets, and they were freely referred to as cranks. Their works in general remained either unknown or were only recognized years later. Thomas Huxley said that it was the fate of every new truth always to be treated at its conception as a heresy. Rocket enthusiasts remained in obscurity not only because they believed in a heresy, but also because, in those years, there really was no need for rockets. They were not on the agenda because they were not needed.

For military purposes the calibres of gun barrels were being increased and the range and accuracy of artillery being improved, and the new projectile, strange, unreliable, and far from perfected, offered artillerymen no advantages. Aviation, still in its infancy, was not able to leap into the era of jet-propulsion by-passing the era of pro-

peller-driven planes*. The first experiments in employing rockets to propel various types of land transport, too, could not be described as promising. Study of the stratosphere was then done primarily with aerostats. And they did very well without rockets. In the summer of 1901, for instance, Berson and Süring in Germany reached an altitude of 10 800 metres, a very considerable achievement.

The theoreticians of rocket engineering and its practitioners had absolutely no connection with one another. Their work amounted to that 'uncoordinated research and experiments on the part of numerous isolated individuals, who attack the unknown territory with their scattered forces like the attack of a swarm of nomadic horsemen, about which Engels wrote in his *Dialectics of Nature* in connection with electricity. The American Robert Goddard, who began work on rockets in 1907, for a very long time knew nothing of the work of Tsiolkovsky. The same is true of Hermann Oberth working with liquid fuel rocket engines and rockets in Germany. Just as isolated was one of the pioneers of astronautics in France, the engineer and pilot Robert Aino-Peltry, future author of a two-volume *Astronautique*.

It may be presumed that young Sergei Korolev knew of the work of these men at least by hear-say. For instance, Goddard publicized the launching of a rocket to the Moon for 4 July 1924 all over the world. That day the man who actually sent the first rocket to the Moon was presenting his first project at the OAVUK in Odessa and was up to his eyes in glider circles. The flight of Goddard's moon rocket had extensive press coverage, and Korolev was probably aware of it.

That same year he probably saw the very popular Soviet film *Aelita* based on Alexei Tolstoy's fine science-fiction

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* The Wright brothers' first powered flight took place in the same year as the publication of Tsiolkovsky's memorable book, 1903.

story. In 1924, too, he may have read the magazine *Engineering and Life*, which published an article by F. A. Zander 'Flights to Other Worlds', or have seen a newspaper report on the founding of a 'Society for the Study of Interplanetary Communication'. Or, he may have read in *Izvestia* (13 June 1924) an article entitled 'The Notorious Rocket' in which enthusiasts of astronautics were termed 'Russian Cyrano de Bergeracs', in a reference to the novel of Cyrano de Bergerac *l'Histoire comique des Etats de la Lune* (Flights to the Moon), published in 1649, in which, incidentally, the French dramatist, without knowing it, arrived at the principle of rocket propulsion.

The year Korolev finished at the Odessa Building School was the year of the Great Mars opposition, and people were talking again about canals, and Martians, and flights to the stars, and that, too, could have been imperceptibly stamped in his memory.

And in Kiev! In preceding chapters we told about the circle that later became the Society for the Study of Universal Space, and about its exhibition in Korolenko Street. The year Korolev left Kiev saw the second edition of Tsiolkovsky's *The Study of Universal Space by Means of Rocket Devices*. The book attracted attention; interest was stimulated by newspaper articles and lectures, and even by *Aelita*. It is possible that Korolev learned about it.

I am almost certain he was present at an evening meeting on 'From Human Flight in the Air to Flights in Universal Ether' on 8 April 1927, for it took place at Moscow Tech and Prof. V. P. Vetchinkin had very strongly recommended his students to attend the lectures of the inventor and flyer G. A. Polevoy and the builder of a rocket-driven car, A. Ya. Fedorov. Korolev would have remembered the latter from his Kiev days. And two weeks later the First World Exhibition of Interplanetary Apparatus and Devices was opened in Moscow at 68 Tverskaya St. (now Gorky St.). A crowd was continually gathered in front of the

huge display of a lunar landscape with Earth on the horizon. A little plywood man in a spacesuit stood on the summit of a crater with a silvery rocket visible in the distance. The initiator of the exhibition was this same A. Ya. Fedorov, a man of extraordinary talents and enthusiasm, one of the organizers of the Interplanetary section of Association of Inventors—a 'non-class, non-political association of cosmopolitans', as they called themselves. The Association was even working on a language of its own, AO, to facilitate communications between the cosmonauts of various countries. For all the arrogance, artificiality, and affectedness of its slogans—'Through AO we'll do everything!', 'We, citizens of the cosmos, will find the roads to other worlds!'—the exhibition was really interesting. Big, well-dressed stands with numerous models, blueprints, drawings, photographs, and offprints from papers and books were devoted to the work of K. E. Tsiolkovsky, F. A. Zander, R. H. Goddard, Max Valier, H. Oberth, and other pioneers of astronautics. The organizers of the exhibition had no idea of all the complexities of space flight, but they sincerely believed in its reality and infected others with their conviction, and infected them so thoroughly that soon long columns of names were inscribed in the special book at the exhibition where those who wanted to fly to the Moon could enter their names. And many of them certainly lived to see the first lunar expedition of Earthmen!

In 1928 the Gas-dynamics Laboratory in Leningrad began work on solid propellants and later on electric and liquid-propellant rockets. And that same year F. A. Zander designed his liquid-fuelled engine, or 'motor', as he called it, the OR-1 (meaning Experimental Rocket No. 1).

The year Korolev graduated from Moscow Tech Tsiolkovsky published a pamphlet in Kaluga *Cosmic Rocket Trains* and summed up his theoretical studies in this field in his *Papers on the Space Rocket*. He was aware that a

new stage had now set in, that of experiments and concrete engineering designs.

'The value of my works,' he wrote, 'lies mainly in the computations and the results that follow from them. On the technical aspect I have done almost nothing. A long series of experiments, constructions and training is needed. That is the practical road and will give us the technical solution of the problem. A long road of experimental work is inevitable.'

On 14 May 1927 Tsiolkovsky wrote to Prof. N. A. Rynin in Leningrad: 'Relative to the cosmic rocket one thing is beyond doubt, that the idea of a reaction device for interplanetary travel has begun to spread rapidly in recent times.'

Yes, indeed. The idea literally floated in the air. The obstinate artillerymen still sniffed at the 'rocket', but on 3 March 1928 smokeless-powder reactive projectiles were fired for the first time in the USSR. Hermann Oberth, yesterday unrecognized, was welcomed with open arms by Fritz von Opel, the automobile king. Prodigious publicity for rocket-propelled cars was planned. Film companies offered Oberth big money to film Thea von Garbu's novel *A Woman on the Moon*. And the title of Oberth's book, *Wege zur Raumschiffahrt* ('Way to Space Travel') published in 1929 was full of confident business-like optimism.

In the United States of America Robert H. Goddard, a man with a difficult, complex character, preferred to work in secrecy, with a narrow circle of trusted people who obeyed him blindly. In the words of one of his American colleagues, Goddard considered rockets his private hunting ground and regarded everyone who was also working on this problem as poachers. Such a standpoint caused him to foresake the scientists' tradition of reporting his results through the medium of scientific journals.

But it was not just a matter of the American's difficult character. His work now no longer belonged to him. Having guarded against poachers he had imperceptibly been con-

verted from a master hunter into a guide and pathfinder. He was now receiving a special grant to experiment on rockets. On the initiative of Colonel Lindbergh, the aerial conqueror of the Atlantic, a fund of 100 000 dollars had been set up to finance Goddard's work on rockets and he himself was now a colonel, too. The military authorities had become interested in his research. It matters little that the Moon shot boiled down to a newspaper story, that his rockets, instead of taking off vertically, described an arc and came down. The main thing was recognition. In July 1929, in Worcester, Goddard's rocket, propelled by liquid hydrogen and liquid oxygen, rose to a height of 300 metres. Now he understood that it was still a very long way to the Moon, but he was an optimist.

As regards how long it would be before a rocket could be successfully launched to the Moon, Goddard wrote that he thought it might well be within the then generation. He was right. The Soviet Luna-2 first reached the Moon 30 years later.

At the beginning of the Thirties a spirit of experiment pervaded rocket engineering. Tsiolkovsky predicted that only by way of numerous and dangerous experiments can the system of interplanetary ship be developed. Real work and concrete experiments became vital necessity. To carry them out in the USSR in those years was quite difficult because of lack of funds. There is an interesting remark in Yu. V. Biryukov's paper 'The Role of S. P. Korolev in the Development of Soviet Rocket Engineering during its Birth and Formation':

> 'The great prospects that application of the principle of reaction propulsion offered artillery and aviation were already understood at the time by many people, but it was still very difficult to get a chance to work on bringing them to fulfilment. N. A. Tikhomirov and V. A. Artemiev (leading pe-

ople at the Gas-dynamics Laboratory) succeeded in this in Leningrad because they undertook to solve a narrow but quite practical problem, but F. A. Zander in Moscow never managed because all his proposals, even when intended to resolve the most immediate concrete problems of rocket engineering, were inevitably linked with the problem of interplanetary flight. It was a vicious circle. To realize the idea of rocket flight, public recognition was required, which would bring the funds needed. But the best, and almost the only, way to win public recognition then for the idea of reaction propulsion was to demonstrate rocket flight in practice. Korolev's role first became decisive in breaking this vicious circle.'

In 1931 a voluntary Bureau of Flight Engineering was organized under Osoaviakhim, and Ya. E. Afanasiev was elected chairman. A member of the Communist Party since 1918, he had worked in the Volga Military Area, and in 1928 had graduated from the Zhukovsky Academy and taken part in the drafting the first five-year plan for the aviation industry. At 38, Afanasiev already wore the insignia of an Air Force engineer of the highest rank. The Bureau, which was located in the premises of the research section of the Central Council of Osoaviakhim, soon attracted activists of the most varied composition, education, and interest. They soon divided up into four research groups, which were advised by such eminent consultants as V. P. Vetchinkin, B. S. Stechkin, V. S. Pyshnov, and B. N. Zemsky. The first group was occupied with light sports aircraft. It was helped by the second group whose members organized the production of these planes. The third group consisted of the 'stratospherists' who were building stratostat Osoaviakhim-1 for an attempt on the altitude record. The fourth group was called the Group for Studying Reaction Propulsion. The main impetus to

its creation was the engineer Friedrich Zander. The group was soon re-named the Central Group for the Study of Reaction Propulsion (GIRD).

The Moscow group was described as 'central' because similar groups were set up at the time in Leningrad, Kharkov, Tiflis, Baku, Arkhangelsk, Nizhni Novgorod, Orenburg, Dniepropetrovsk and other towns, even up in Kandalaksha, near the Polar Circle, where a home-made liquid-fuelled rocket was launched (later in 1935). Apart from the objective factors that stimulated interest in rockets and the problem of interplanetary communication, about which we have already spoken, the growth of these groups was fostered (and is explained) by the numerous publications on the subject. Apart from Tsiolkovsky's works a book had been published in Novosibirsk by Yu. V. Kondratyuk *The Conquest of Interplanetary Space*, and popular science articles and science-fiction stories were appearing regularly in magazines and newspapers.

The Leningrad Professor N. A. Rynin, author of a unique, multi-volume work on rocket engineering and interplanetary flight that has now become a bibliographical rarity, had done much to publicize rocket flight. He was a man of encyclopaedic education and probably knew everything that had ever been published about rockets. In his home a huge frame hung on the wall with photographs of everyone who had worked in the field of rocket engineering.

But the most popular books in those years, especially among the younger generation, were those of that classic of Soviet popular scientific literature, Yakov Perelman*. His *Interplanetary Travels* and *To the Moon in a Rocket* were not only scientifically accurate, but full of exceptional faith in the reality of man's cosmic roads.

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* Yakov Perelman's *Physics for Entertainment* and *Figures for Fun* have been published in English in many editions by Mir Publishers, Moscow.

'I don't know whether I shall live to witness the hour when a rocket ship will hurtle into celestial space and carry the first men to the Moon,' he wrote. 'But you, young readers, will very likely live to see the day when regular flights will be established between the Earth and the Moon and—who knows?—perhaps, some of you will be lucky enough to make that trip yourselves.'

More and more new enthusiasts were being born daily and the popularity of reports, lectures and debates of every kind was so great that they often went beyond the allotted time and had to be adjourned to another day, and the crowds had to be controlled by the militia. Leading scientists took part in the debates, which were usually accompanied with displays of visual aid and illustrated with mathematical formulae and quotations from the foreign press. The audience got the illusory impression that interplanetary flight, the theoretical possibility of which was beyond doubt, was a purely technical problem, intricate, but quite realizable at the then level of science and technology. Hardly anyone today would be inclined to believe the announcement displayed on a hoarding inviting him to take part in an expedition to Mars. But they believed it then! And Alexei Tolstoy, a great artist, had depicted in his *Aelita* a quite real Gusev who read such an announcement—what's more—without surprise! Hundreds of Gusevs sat in the lecture halls of Moscow University and the Polytechnical Museum and believed that such an announcement was likely to appear tomorrow. Or if not tomorrow, then on the next day. Was it only young hot-heads that believed in it?

Even F. A. Zander, who had himself experienced all the hardships of the first strides, was very optimistic.

'Being interested in mathematical and constructional investigation relating to interplanetary travel, I have been making calculations pertaining to this problem for several years and have come to the conclusion that, with existing

engineering, flights to other planets will become a reality in the next few years,' he wrote.

Zander was too committed to be objective. One of the tragedies of this outstanding intellect was that his engineering solutions, however mature, did not correspond to the technical possibilities of his time. Zander's projects were several decades ahead of his age. Even to-day, when we receive information from the surface of Venus and men walk on the Moon, science and engineering are unable to realize some of his ideas*.

Strange as it may seem, it was Tsiolkovsky, seemingly less familiar with the practical situation than the others, and having less idea of the possible scope of the design work and of the necessary industrial level, who was the most reserved in his forecasts.

'Those working in this field must expect great disappointments,' he wrote in 1929, 'for a favourable solution of the problem is much more difficult than the most penetrating minds imagine. Their failures, and the exhaustion of their forces and hopes, will make them abandon the task unfinished and in a pitiful state. Time and again new reinforcements of fresh and dedicated people will be needed... . The impression that the problem is easy to solve is a temporary delusion. It is nice, of course, because it gives pluck and strength. If the difficulties of the business were known, many of those who are now working with enthusiasm would recoil in horror... . They are bound to achieve success, but the question of when they will achieve it is quite hidden from me.'

Such was the world that Korolev was entering. The world of the hermit of Kaluga and of Fritz Opel's advertiements, the world of blabber about the AO language and

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* As an example, we may cite his idea of using the metal structural elements of space rockets as fuel. Although the advantages of this idea are obvious it is still not realizable in our day.

of Goddard's colonel's uniform, the world applauded by the audiences in the Polytechnical Museum and the University and ridiculed by satirists and cartoonists. Very different people inhabited this world. Korolev, too, was unlike any of them. He entered it quietly, without fuss, with a clear idea of what he wanted and how it could be achieved. He understood the whole depth and audacity of the idea of an interplanetary flight. The idea of it seized his fancy, enthralled him, made him fall in love with it, but his head remained cool. He remained faithful to the motto of his youth: 'To build flying apparatus and to fly it'. It would be untrue to suppose that the beginning of the Thirties was some sort of turning point, that there was a complete change of interests, that the aviator Korolev, having read Tsiolkovsky's pamphlets, had his eyes 'opened' and was converted into Korolev, the rocketeer, burning with desire to fly to Mars. The principle of rocket flight gave him, before the Moon and Mars, unprecedental speed and complete freedom from the atmosphere, and that meant the possibility of reaching altitudes one could not dream of, with piston planes that were strangled in a rarefied atmosphere. The transformation of the aviator into a rocketeer took many long years. From a rocket engine in a glider to a high-altitude plane, and from that to a rocket plane—a winged rocket flying in the stratosphere—was not a chain that came suddenly into his head.

For many years—seemingly right up to the end of World War II, Korolev was searching for ways of combining aviation and rockets. All that time he remained at heart an aviator. In those years the rocket did not exist for him in 'pure form'. It was not the end in itself, but a means to an end. When we analyse his activities and everything he wrote and said in the Thirties, we come to the conclusion, speculative, of course, that ideally, if nothing interfered with the realization of his plans, he would probably have taken quite another road into space. He would perhaps

have put into orbit as a satellite of our planet not a multi-stage ballistic super-rocket starting from the Earth, but some kind of stratospheric rocket-plane, a winged vehicle with a rocket engine carried up to the limits of the stratosphere by a heavy carrier plane, something rooted in its technical genealogy in aviation.

It might have happened that way, but it didn't. Things happened the way they had to happen.

CHAPTER 16

It was decided not to hold a glider meeting in Koktebel in 1931, and as the summer days came Korolev's spirits began to sink. This empty summer was so unlike the last one when he had spent whole nights, until the windows turned blue, making the drawings for his glider. But the emptiness was only his impression, all his evenings throughout June were spent on the TB-5. The engine group did all it could do to keep their heads above water. During one of those evening vigils Korolev left his desk, stretched his limbs and said out loud: 'You know what? We've decided to set up a glider school at our factory.'

A clamour broke out; everyone liked the idea. No one asked who precisely were 'we'. There was no 'we'. Korolev organized everything himself. He talked Igor Tolstykh into giving them his IT-4 glider at Glider Station, wrote a letter to Oleg Antonov asking him for the blueprints for Standard, a simple and reliable glider. When Antonov's blueprints arrived they began building two gliders at the same time at the Tomsky Stadium (now the Young Pioneers' Stadium). Now Sergei regained his composure; life took on the rate which he was accustomed to.

But one day this customary rate was disturbed by an extraordinary event. Two trips to the Donbas and the avalanche of letters sent there from Moscow at last had their effect: Lyalya came to see him—just for two days. They spent August 5th out of town and on the 6th went to the

Registry Office. What he yearned for all these years suddenly came true, quickly and very simply. There was no wedding, or rather there was a very small and short wedding party. Their only guests were Mikhail Gromov and Dmitry Koshits, who congratulated the newly-weds, drank a quick bottle of champagne with them, helped the bride into a cab and rode with her to Kursk Station; Lyalya went to Kharkov and from there to the Donbas to make arrangements for her transfer to Moscow. Everything was done rather clumsily and hurriedly, and sadly.

'Now, husband, let's go home,' said Koshits with affected gaiety, clapping Sergei on the shoulder.

Korolev smiled; this new title, 'husband', sounded strange and unfamiliar.

The affairs of the new glider school (a circle would have been a more appropriate description) made Korolev a frequent visitor at the Central Council of Osoaviakhim, where the Bureau of Aviation Technology was located, and he soon became a member of the Bureau. It was there on Nikolskaya Street that he met Friedrich Zander and very soon became someone absolutely indispensable to the Group for Study of Reaction Propulsion.

In a letter to K. E. Tsiolkovsky dated 20 September 1931, the secretary of this group wrote about its work plans as follows:

> '... popularization of rocket propulsion, lecturing, laboratory work, etc. The main thing is the application of reaction devices and experiments.
>
> 'In order to gather the necessary activists around the Group and collect enthusiasts, and in order to rouse public opinion as it ought to be and put our problem on the agenda as befitting the rocket era that is beginning, we are building the first Soviet rocket glider.'

What he referred to was Korolev's rocket glider.

Korolev kept no diary and seldom wrote his ideas down. It is difficult to say when he took it into his head to marry a glider and a rocket engine. He was always a realist, and the idea could have taken real shape only toward the close of 1930; on September 9 Zander made the first tests of his OR-1 engine. About the same time—in 1930-1—a young engineer from the Gas-dynamics Laboratory in Leningrad, B. P. Glushko, and his colleagues carried out a series of experiments and built two experimental rocket engines, the ORM-1 and the ORM-2. It is impossible that Korolev knew anything about this work then as the activity of the Laboratory, a defence organization, was not publicized.

In the second half of 1931 Korolev, having obtained the support of the active core of GIRD, began very resolutely and persistently pushing the idea of a rocket plane. He wanted at all costs to avoid amateurism, stressing everywhere and on every occasion that a rocket plane was not one of Zander's mad ideas, nor a whim of his own, but something of general interest to Osoaviakhim, and a matter of state importance. His energy infected Zander, who was perfectly helpless in organizational matters. Zander felt that this time his ideas and dreams might possibly become real solid constructions. That was how one of the most interesting documents in the history of Soviet rocket engineering came to be.

'NOT FOR PUBLICATION

THE OSOAVIAKHIM UNION
OF THE USSR AND OF THE RSFSR

Socialist Agreement on Strengthening the Defence of the USSR, No. 228/10, 18 November 1931.

We, the undersigned, being on the one part the Chairman of the Bureau of Aviation Engi-

neering of the Research Department of the Central Council of Osoaviakhim of the USSR, designated below as the Bureau, Com. Afanasiev Ya. E., and the senior engineer of the First Laboratory of the Department of IAM Petrol Engines Com. Zander F. A., on the other part, designated below as Com. Zander, have drawn up the present agreement under which Com. Zander takes on:

1. the designing and preparation of working drawings, and construction of the experimental rocket engine OR-2 for the reaction-propelled plane RP-1, to wit: a combustion chamber with a de Laval nozzle, fuel tanks with a safety valve, and a petrol tank to be ready by 25 November 1931;

2. a compensator for cooling the nozzle and heating oxygen to be ready by 3 December 1931;

3. the calculation of combustion temperatures and of flow speeds, and of the axial pressure of the jet for various pressures in space, of the weight and on flying times for various amounts of oxygen, the analysis of the heating and cooling systems, and approximate analysis of the walls of the combustion chamber, to be ready at the same time as the drawings; the making and testing of the nozzle and combustion chamber by 2 December 1931; the testing of liquid oxygen and petrol tanks by 1 January 1932, the testing of the assembled device by 10 January 1932, and installation in a plane and testing in flight by the end of January 1932.

Note. In the event the projected improvement requires a direct and inverse taper, the

analysis and drawings of the said direct and inverse taper to be submitted before 15 January 1932.

For the work carried out Com. Zander is to receive a remuneration of 1000 roubles to be paid (on fulfilment of the work) in installments of 500 roubles at the beginning of the period of acceptance, 20 November 1931, and on the completion of the work.

The agreement has been drawn up in two copies; one is to remain with the Central Council of Osoaviakhim, and the other in the Osoaviakhim IAM Cell.

18.XI. 1931 Ya. Afanasiev,
Chairman of the Bureau
F. Zander,
Responsible executor'

At this time the Central Design Bureau and the Menzhinsky Works, having produced their new No. 8 machine, as the TB-5 was called in documents, entered a phase of new reorganization which, as you will see, again made it easier for Korolev to carry out his new plans.

Despite the fact that, in the summer of 1930, there were only three major experimental aircraft construction centres in the USSR: the Central Aerohydrodynamic Institute, the Central Design Bureau and K. A. Kalinin's design bureau in Kharkov, the quite crazy decision was taken to merge the first two. It was crazy because, under A. N. Tupolev, an excellent school of aircraft designers was coming into being at the Institute, while Grigorovich's and Polikarpov's groups were working at the Central Bureau. It would have been more logical, on the contrary, to bud off new bureaus from these well-established organizations, to put talented young constructors at their heads, and

thus to broaden the front of experimental aircraft construction. That was what had been done later. As is well known, however, every rule has its exception; and the authorities, profiting by Tupolev's absence on business abroad, issued an order merging the two organizations on the basis of the Central Institute.

The two were then to some extent rivals, since they were constructing similar machines: the TB-5 at the Bureau and the TB-3 at the Institute. When the merger order was issued it was already clear that the Institute had won hands down: Tupolev's machine was obviously the better. It didn't take an experienced psychologist to understand that in such circumstances no good would come of the merger. Rumours flew about that they wanted to deprive the Institute people of their independence and autonomy and to put them under a new management. About a thousand people were shifted about and redistributed. Real and imaginary wrongs immediately sparked off conflicts. Quite absurd collisions sometimes occurred. Tupolev, for example, found himself deputy of the deputy chief of the Bureau A. N. Raphaelyants. He protested to Voroshilov. Four days later the order was rescinded. In fact, the merger never went through, but for some time they remained united territorially. In the end some groups went back to Menzhinsky Works, and the rest stayed with Tupolev.

During all these organizational adventures Korolev, having been moved to the Institute, became a leading engineer on the autopilot. This autopilot, one of the first in the USSR, was later installed in the TB-3. It will readily be noted that during his very short time at Richard's bureau and at the Central Bureau Korolev had been constantly changing his engineering specialty, doing pure design work, working on aircraft armament, engines, and instruments. It could be called a search for his niche, but it was rather a desire to synthesize his engineering knowledge. Somehow he instinctively felt that the time was coming

when he would have to deal with both aerodynamics and thermal processes, with automatic control and the fine points of choosing between designs.

And how did Korolev profit from the transfer to the Central Institute? In fact, he now found himself under one roof with Zander and was able to discuss his plan with the latter almost daily. The essence of the plan was to install Zander's engine on Cheranovsky's glider and to fly this extraordinary contraption.

V. B. Shavrov, the historian of Soviet aviation, wrote in this connection: 'B. I. Cheranovsky occupies a special place among the Soviet aircraft constructors owing to the unusual layout of his gliders and planes. He was the originator of tailless aircraft in the USSR and the first in the world to construct an actual thick-section aerofoil. During his career he built some 30 planes and gliders, but his fame is due to his Parabolas, aircraft with wings of parabolic plan.'

Cheranovsky was older than Korolev and notorious for his awkward, unsociable character. This unusually gifted man would not tolerate any comment. Advice annoyed him and doubts about the correctness of his views would lead to a break of relations. He was unable to work within a team. His capability for work was such that he was a whole team in himself. And it was with this man that Korolev now wanted to make an alliance. It seemed to him that the geometry of tailless gliders best suited his idea. If a rocket engine were to be installed near the tail of a conventional glider, the latter would not be able to fly because of the shift in the centre of gravity. If it was placed in the belly under the pilot's seat the jet of hot gases leaving the nozzle would burn the glider's tail off. Korolev realized that neither Koktebel nor his favourite Red Star were any match for Cheranovsky's tailless machines: the very layout of the Parabola precluded any difficulties.

Korolev was always noted, incidentally, for the excep-

tional objectivity in his evaluation of the work of others. 'It may be worse but it's mine' was never his motto. He understood that no one, neither the greatest of constructors, nor even the most talented team could guarantee that somewhere, somehow, someone would be able to do it better. He hated being beaten, and it was never easy for him, a vain man, to acknowledge the success of others. But still, he was objective.

He met Cheranovsky at Glider Station. The building of the two gliders from Antonov's blueprints was finished and they had been brought out for testing. Korolev's very first flight in the new machine almost ended in disaster; the glider dived steeply and resumed only level flight by some miracle near the ground. Korolev was very excited, and was laughing:

'I pulled the stick, no effect! What to do? I pushed, then pulled it again, and managed to land. Now let's see what is the trouble. A defect in the elevator controls. We'll have to write to Antonov, there's something here he didn't think of.'

Cheranovsky listened to this hefty red-cheeked lad, and smiled. He liked him. The lad came here with a friend on his motorbike and taught the boys to fly. It was clear he liked flying himself. And when Korolev mentioned in conversation that he would like to fly the tailless glider Cheranovsky unexpectedly, even for himself, agreed.

In October 1931 Korolev imperceptibly shifted all the work in the glider school he had organized onto Pyotr Flyorov and began mastering the BICH-8 tailless glider. At first he made take-off runs, then flew up. He was primarily interested in the flight stability of this unfamiliar design to the eye of the aviator. At first the BICH would dive, descending rapidly at small angles, but gradually Korolev 'broke it in' after 12 flights. In general, he was not enthusiastic about the BICH-8. In particular the cabin annoyed him. For broad-shouldered Sergei it was too cram-

ped, and he felt that if he moved his shoulders freely it would fall to bits. The glider was old and decrepit, and was so dilapidated that it would be foolish to install a rocket motor in it.

'But, Comrade Cheranovsky, you've got the BICH-11, haven't you?' Korolev pressed him. 'That's what I would like to try. The rocket engine is quite compact, we'll place the tanks in the wings... .'

'But where is this engine of yours?' Cheranovsky asked mistrustfully.

'It will be. You've seen the OR-1. And now Zander is building another, much more powerful one.'

Zander began work on the OR-2 in September and October, when Korolev was flying the tailless glider. At the end of 1930 he had gone to work at the Central Institute for Aeroengine Engineering, but had very soon, in March 1931, joined the Central Aerohydrodynamic Institute. There he became close friends with Korolev and with another engineer, Yu. A. Pobedonostsev, an ardent enthusiast of rocket flight. Korolev proposed using Zander's engine in a glider, Pobedonostsev suggested using it right away in a jet plane. These too ardent enthusiasts both pleased Zander and frightened him. It was a long-standing dream of his to install a liquid-fuel rocket engine on winged apparatus; his model of an interplanetary ship had wings, too. But he had built the OR-1 a trifle, as a purely laboratory affair that he needed only to confirm some of his calculations, to clear up certain vague points, and to test the heat transfer equations. And here, right away, they were saying 'glider', 'plane'. He tried to make a joke out of it. 'Look, let's first install my engine on a bicycle, than on a motorcycle or a car, and then we'll let Korolev fly.'

'No, let a puppet fly instead of a pilot to begin with. It's dangerous,' Cheranovsky teased Korolev.

Zander was experimenting with the OR-1 all the summer. He had found a place for his little test stand in the dere-

lict German Church that housed the laboratory of Dmitrievsky, who was working on the superchargers for aircraft engines. It was always dark under the old arches, and when the engine fired the echo changed its roar into devilish laughter. The church was visited by Prof. V. P. Vetchinkin. Zander showed him the OR-1. Vetchinkin stroked his beard, did not interrupt, but his mind wandered. He realized that the man explaining the details of this reconstructed soldering lamp to him had interesting ideas, that it would be well to help him with equipment, and to find him a better place. But how was it all to be done?

Vetchinkin did not know that help was quite near, that the crux of the matter lay not in moving out of the damp church and not in replacing the primitive balance used to measure the thrust. They were not important. Zander's diary contains these notes:

> '5'X—trip to passing-track 133 on the Octyabrskaya railway and to the Osoaviakhim airfield, inspection with Eng. Korolev S. P. of his glider and presence at glider flights.
>
> '7'X—(6th was rest day) preparation and execution of 32d experiment with OR-1 in the presence of Eng. Korolev S. P., Eng. Cheranovsky, techn. asst. Nazarova A. A., techn. Belokurov.
>
> '8'X—talks with Pobedonostsev.
>
> '9'X—talks with Pobedonostsev and Merkulov.'

There, in the church, Vetchinkin could not know that help was to come from these still unknown young men, his students of yesterday, who were carried away by Zander's dreams, and who felt an urgent need for this reconstructed soldering lamp roaring under the Gothic arcs.

What a wonderful man Zander was!

He was born in Riga, in an intellectual German family whose well-being had been destroyed two years after his

birth by the death of his mother. His father, a doctor, had tried his best to fill the big two-storey house and orchard with joy and peace. There were lots of toys and pets, and in the evenings he would tell the children stories about the stars and the planets. Listening to his father Friedrich thought of the dark abysses separating the stars, of the host of other worlds that must certainly exist even if they were very far away. In other people life overshadows these thoughts, but for Zander they overshadowed his whole life.

He graduated with honours from a secondary school and entered the Polytechnical Institute because he had already made up his mind and wanted to obtain the knowledge that would bring him nearer to the stars. The first money he saved he spent on a telescope, and every day, impatiently as a lover, he awaited his rendezvous with the sky. When little Sergei Korolev was learning to walk in a cramped Kiev flat, Friedrich was organizing a student Society for Aeronautics and Flying and had begun making his first, still quite timid, calculations of gas flow. Like all students he was short of time; he was always in a hurry and to save time took all his notes in shorthand. From 7 February 1909 he wrote all his papers in strange flowing signs resembling the calligraphy of the Georgian alphabet. Much labour has been spent since on deciphering them, but many pages, still undeciphered, remain in the archives.

His engineering degree in technology gained, Zander went to the Conductor Works which processed rubber. He had decided to learn precisely how rubber was treated because, for a ship flying in airless space, rubber would be needed as a reliable sealing material, apart from which it was also an excellent insulator. He talked about it quite seriously.

In 1915 the war forced him to move to Moscow. Now he was solely occupied with space flight. That, of course, should not be taken literally; he was working at the Motor Aircraft Works, doing something or other, making compu-

tations and drawings, but all his thoughts were in space. Blinded by his dreams he was sure he could convince others of the urgent need for interplanetary flight. And he painted a fantastic picture for them that had come to him in his boyhood:

> 'Who has not, staring up into the sky on a clear autumn night at the bright twinkling stars above him, thought that, maybe, on distant planets, there are intelligent beings like us, whose culture is many thousand years ahead of ours. What countless cultural treasures could be brought to the Earth and to Earth's science, if man were able to fly out there, and how small a sum needed for such a great cause compared to what man spends wastefully.'

He said it quietly, but with such force that it was impossible not to believe him. A leading engineer recalled that he 'spoke of interplanetary flight as if he had the keys of the cosmodrome in his pocket'. It was impossible not to believe him. And people did believe him while he was talking. But he would stop, and then many began to think that he was probably a crackpot. Because the way they saw it, people who want to heap immense treasures on the world and went hungry in order to do so have always been cranks.

And he went hungry when he was making the calculations for a winged machine that could carry a man beyond the atmosphere. He was so engrossed in this work that he left the factory and for 13 months worked solely on his interplanetary ship. His money was all gone, but happily, among the people whom he had told about the stars, there were those who refused to regard him a crank. In his autobiography he wrote:

> 'While working at home I suffered great privation and was forced to sell my astronomical telescope.

But the red cadets from the Kremlin were interested in it and bought it from me for the club of the All-Union Central Executive Committee, so helping to continue my work. Moreover, the workers of the Motor Works also supported me by collecting two months' pay for me. That was the first donation to the cause of interplanetary communications.'

People who knew Zander and worked with him noted that no business and no conversation not connected with interplanetary travel interested him in any way. He just did not take part in them and often went away. But he was interested in everything that might be linked with space flight. He thought Tsiolkovsky a genius and could sit for days at his desk with his half-metre slide-rule affirming that work did not tire him. He taught himself to hold his breath: the supply of air in a spaceship would be limited. He drank baking soda: in a spaceship it would act as a tonic. He grew plants on charcoal: it would be better to take light charcoal in a spaceship than heavy earth.

When he was ill friends came to see him. Zander had a fever, and it was frightfully cold in his room. He lay under several blankets, a coat, and a rug. They began straightening up his bed and found thermometres under the rug, under the coat, and between the blankets: he was making experiments in heat conductivity, for the side of the interplanetary ship facing the Sun would absorb heat intensely, while the side in the shadow would be cooled.

It was as if his whole brain was an interplanetary ship although he loved nature and was very fond of children—his own and those of others. He married quickly, surprising even himself. A girl and a boy were born. He gave them astral names, Astra and Mercury. Neighbours shrugged their shoulders: no one gave such names. Neighbours laid complaints against him: his balcony stank, he was investigating the possibility of using excrement for hydroponics,

and was refining urine. Neighbours pointed their fingers at him: 'There goes that fellow who is going to Mars'.

If they could only understand that he was, indeed, going to Mars! In a frenzy of fanatical work he would suddenly clench his fingers behind his head and, taking no notice of who was around, would exclaim passionately and loudly: 'To Mars! To Mars! Forward to Mars!'

How easy it was to be mistaken about him and take him for a fanatic, or rather for the crazy inventor of a mythical apparatus, whose inflamed brain knew no respite. How much he really resembled those unhappy eccentrics for whom some feel squeamish contempt but about whom others have qualms of doubt wondering whether they are turning a genius away.

But he was no crank. His fantasies were not up in the clouds but were firmly bedded in engineering by the iron logic of mathematics. Years later I. F. Obraztsov, Corresponding Member of the USSR Academy of Sciences, paid the following tribute to Friedrich Zander:

> 'The peculiarity of Zander's creative approach was his thorough mathematical treatment of every problem he set himself. He did not simply give the problems under consideration deep theoretical treatment, but he strove, with the clarity of exposition peculiar to him, to present his own interpretation of the problem that troubled him, and to find ways to carry it out in practice.'

Zander was a brilliant engineer of great erudition, and the level of his mathematical knowledge and the skill with which he made the theoretical analysis of a process that interested him were evidently superior to those of the best engineers working in rocketry in those years. And unlike Tsiolkovsky Zander not only did not shy away from practical work in this field, but actually became the first man in the USSR to take the first steps to turn astro-

nautics into an applied science. The implementing of Tsiolkovsky's ideas in fact began with the building of the OR-1 engine and the first liquid-fuel engines of the Leningrad Gas-dynamics Laboratory*.

A well set-up, or rather simply a lean man with a short ginger beard and moustaches, a dry, even an ascetic, face and blue eyes, that were stern and at the same time childishly helpless, who spoke slightly broken, strange sounding Russian, poorly, shabbily dressed, but never noticing it—that was how Korolev saw Zander in one of the buildings of the Central Institute in what is now Radio St., and he knew at once that this was the man he was looking for.

GIRD, being a voluntary organization, and part of another voluntary organization, Osoaviakhim, made no demands for money, premises, or materials. It was nobody's rival and got in nobody's way. Its debates and exhibitions only increased Osoaviakhim's popularity, great as it already was. But as soon as Zander began to raise the matter of the need to start practical work on preparations for interplanetary flights there was instantly a wary reaction in Osoaviakhim. No one willing to put his signature to the estimates for a bureau for building spaceships could be found. No manager was inspired by the prospect of a flight to Mars, even in the near future. All the 'businessmen', or as we now say, 'financially responsible persons', treated the whole affair almost as a fraud. No one refused to listen to Zander's heated eloquence, but to build him a factory, that was another kettle of fish. It wasn't serious proposi-

* The work of the Gas-dynamics Laboratory, of course, deserves much fuller treatment than it is given here. My fear is that the panorama of the youth of one man would turn into a far from full history of rocketry in the USSR.

tion. Some treated the 'interplanetaries' as nice, but over-enthusiastic people, others as half-crazy fanatics. In 1934, after the first Soviet liquid-propellant rockets had already flown, a novel came out depicting a villain with every possible vice and in addition absorbed in problems of interplanetary communications. Korolev was beside himself with fury and tore the novel to pieces at a conference.

The following episode illustrates the attitude toward 'interplanetaries'. The 4th International Congress on Aeronautics was to be held in September 1930 in the Hague. As early as January Zander, then at the Central Institute, wrote a summary of his paper to be sent to Holland. Its title was 'Problems of Super-aviation and Current Tasks in Preparations for Interplanetary Travel'. The paper was discussed and approved by a technical meeting, and was highly commended by Prof. V. P. Vetchinkin; it summed up material of great originality. In April the report was sent to the All-Union Aviation Corporation. On May 6th, it was translated into French, and on May 18th, the head of the Corporation I. Mikhailov sent it back to the Institute. The accompanying letter, addressed to the Institute's Director S. A. Chaplygin, suggested that it be sent in the name of the Institute, because the Corporation, as an industrial organization, 'does not deem it possible to pronounce on the question of interplanetary communications'. To have anything to do with the 'interplanetaries' would mean to give an organization a name for frivolity.

Despite the popularity of the idea of space flight itself, the attitude toward attempts to realize it was then highly sceptical. At the 18th International Astronautical Congress in Belgrade in Septemer 1967 on the history of astronautics papers were read by F.J. Malin (USA), Hermann Oberth (West Germany), L. Crocco (Italy), L. Damblanc (France), and others.

Malin said they had studied the works of the first generation of theoreticians of space flight—K. E. Tsiolkovsky

(1857-1935), Robert Goddard (1882-1945), R. Esnault-Pelterie (1881-1957) and Hermann Oberth—that had normally been treated as science fiction in scientific circles primarily because of the fantastic discrepancy at the time between the experimental rocket motors and the actual requirements for a rocket engine intended for space flight, and the negative attitude went so far as to include the principle of rocket propulsion itself.

Oberth recalled it had proved impossible to get authoritative scientists to listen to him and to think about his proposals, and that the only chance he had of making them listen was to draw public interest to his ideas.

Crocco, son of General G. Crocco, the leading Italian rocket specialist, said that responsible people in the Air Force evinced very little interest in the future of rocket motors. The interest of the Italian administration sponsoring the Croccos had been at freezing point.

And Damblanc, the famous French expert in solid-propellant rockets said that he had taken on much of the work on his own initiative and had had to work alone right to the end without help from qualified specialists.

All of which only confirms Karl Marx's idea that the truth that every beginning is difficult applies to every science. But still one had to start.

Korolev, a real man of business, in touch with reality despite his youth, had an excellent view of the situation developing. He understood that all attempts to build an organization with an interplanetary ship on its emblem were doomed to failure. A quite different trade mark was needed, and what must be offered was not an interplanetary ship, but something that everyone could understand, and that could be realized in weeks or months, and not in years to come. He already saw the people who could become his allies: Yuri Pobedonostsev—he had already been six years

with the Institute and was convinced by Zander's ideas; Mikhail Tikhonravov, whom he had met at the Koktebel rallies and worked with at the Central Bureau and the Institute—Tikhonravov was thinking about a rocket using liquid propellants and had already gathered a small group of faithful collaborators around him; and, finally, the trio of Zander, Cheranovsky and Korolev, with their tailless glider powered by liquid-propellant engines. That was already something concrete. One could ask for money, materials, and premises for such a job. And he needed all three desperately.

Though carried away by his dreams of a rocket plane Korolev realized that it would not be possible to build it in the same way they had built Koktebel, Red Star, or even the SK-4. The work was too serious and the 'home design office' in his mother's flat could not cope. It had now become 'headquarters'. In the evenings Zander, Pobedonostsev, Tikhonravov, and Sumarokova got together in Korolev's room and pondered how to begin.

'If we wait until our organization gets its papers and is officially recognized, we'll have to wait till summer,' Korolev said. 'We must do it differently. First of all, we must find premises where we can meet and start work. That there is no money is not important. As soon as we find a place to work and start working we'll say in Osoaviakhim: "Here we are, we already exist. Here's what we've done. Here's what we propose to do." Right?'

Zander sat warming his thin, pale fingers on his tea-glass and kept nodding silently. At last he said: 'Look you, it will be quite hard to find premises. Who is going to give them to us?'

'Nobody's going to give them to us,' Korolev fumed. 'Don't expect any one to come along, Friedrich, and bring you the keys saying: "Move in, for God's sake." It's no good waiting for premises, we've got to find them ourselves. Find them and take them.'

The search for premises was organized on a 'scientific basis'. Korolev divided the whole of Moscow into sectors, and each one was allotted his sector. No one read advertisements or made inquiries. They simply scoured the streets and courtyards and questioned janitors and porters. And then Korolev remembered the old wine-merchant's cellar in the house on the corner of Orlikov Lane and Sadovo-Spasskaya St., where the constructors of the Moscow Tech gliding school had worked. When he entered the cellar the only thing in it was a torn envelope of a stratospheric balloon which was quite difficult to remove. But the important thing was that the cellar was empty, and they could not be evicted; Korolev soon discovered that it formally belonged to Osoaviakhim. Now they had premises, dilapidated perhaps, and without lighting, but premises!

They themselves did the repairs, whitewashed the walls and put in wiring. And very soon they were in love with it, this cold basement that will always have a place in the history of astronautics.

Every one who belonged to Moscow GIRD agrees that it is hard to name the exact date it was formed, because, paradoxical as it may seem, it not only began functioning long before the order creating it was promulgated, but also before the basement had been found. What brought them together was not a scrap of paper, nor a common roof, but dreams. Korolev had a meeting with Cheranovsky and Zander, and that was GIRD already at work. On the whole it was already in existence toward the end of the summer of 1931. But since chronicles like accurate dates, it must be stated that the first documentary mention of this organization dates from 20 September 1931, when the group's secretary wrote a letter about it to K. E. Tsiolkovsky:

> 'In Moscow, under the auspices of the bureau for aerial engineering of the Research Sector of the Central Council of Osoaviakhim... a group has at last

been set up to study rocket motors and reaction propulsion. I am the secretary of the group, which, by the way, is known as GIRD.'

The formal document appeared much later, on 14 July 1932. It was a long one, with many sections:

'§ 1. Recognizing the great importance of research and experimental work on rocket motors and the application of reaction propulsion within the Osoaviakhim system for the development of the national economy and for strengthening the defence capacity of the USSR it has been decided to concentrate all activity in this field in the Group for Studying Reaction Propulsion—GIRD... .*'

But this activity had already been concentrated for a long time.

'§ 6. S. P. Korolev is appointed head of GIRD (on a voluntary basis) from May 1st of this year... .'

But he had been in command for a long time already.

CHAPTER 17

Quite a few newspaper and magazine articles have been written about the Moscow GIRD, and whole sections and chapters of books had been devoted to it. In some publications it is even possible to trace a covert rivalry with the Leningrad GDL when questions are posed in passing, in a touch-and-go sort of way, as to 'which was more important', and 'which did more', questions that are very much like that dilemma of childhood 'which is stronger, the elephant or the whale?'

But comparisons with the Leningrad group apart, the

* From the initials of the Russian for 'Group for the Study of Reaction Propulsion'.

spectrum of views on the historic importance of GIRD is quite variegated and wide. Some spoke of it as the smithy that forged the cadres of Soviet rocketry, others say that Soviet astronautics sprouted from the seeds of GIRD which put up the first Soviet rockets.

All that is true and yet not true. GIRD existed for about two years, and during that time fewer than a hundred people, including the mechanics, lathe-operators, and service personnel, worked in it. So talk about a 'forge of cadres' is hardly justified. In the post-war boom in rocketry only a handful of former GIRD engineers worked in this field. And the road from the basement in Sadovo-Spasskaya St. to the launching pad of Gagarin's ship was not a straight one either; the connections between them are expressed in complex equations; for, in fact, there are no simple equations in history.

The importance of GIRD, in all probability, is something else. This organization, and also the GDL, were the threshold beyond which words became deeds. GIRD and GDL signified the end of the paper era in astronautics. The rustle of manuscripts with Tsiolkovsky's incredible truths turned into the clatter of metal.

Gagarin's vehicle was programmed in GIRD, of course, just as the genetic code of the organism is programmed in a single cell. Almost all future trends in rocketry and astronautics were concentrated in that little research cell of Moscow enthusiasts, concerned with the construction of rockets, with liquid-propellant motors and supply systems, with jet and ram jet engines; they devised testing techniques, designed ground servicing facilities, thought about a system of observation and control for the rocket in flight and means of bringing its pay-load back to Earth. They were occupied with gas dynamics, heat conduction, materials, the chemistry of combustion, automation, supersonic aerodynamics, and even what became known in the future as space medicine. Very often one engineer would

take on something at GIRD that in twenty-five years' time a big research Institute would be working on, and sometimes more than one institute. It was the institutes that built Gagarin's vehicle.

Finally, GIRD contributed much to Soviet cosmonautics because Korolev profited much from it. Never in his whole life did Korolev experience another period like those two years, 1932 and 1933. It was a time of exceptionally intensive growth. In the course of two years the glider flyer dreaming of adapting engine nobody had seen to a glider became a major expert in the field of rocketry, a specialist with a broad scientific outlook, well aware of the prospects and with a clear picture of the roads to the future. Within these two years an enthusiastic constructor from a 'do-it-yourself bureau' became the head of a whole scientific centre, directing the extremely varied work of dozens of people. It was at GIRD that all Korolev's talents as a leader and an organizer really first came to the surface, talents unusual and very rare even in our country, which is so rich in talent. At GIRD Korolev became Korolev.

There was something else about GIRD, something that was quite irrelevant to what it worked on, rockets or anything else. That was its spirit, the atmosphere of happy creativity that united not only the minds but also the hearts of people. Everyone probably senses what it was and can imagine how it came about, but few are seldom lucky enough to experience in their lives the elated joy of a common ardent interest in their work and of impatient enthusiasm for the work of those next to them. It is something to remember for the rest of one's life. And that is probably the reason, is it not, why on solemn occasions and at top-level meetings Korolev, member of the Academy of Sciences, would suddenly push his way through the dense wall of heroes and prize-winners, generals and leaders of the high-

est rank and hurry to embrace a person nobody knew, who sometime very long ago had spent nights soldering combustion chambers in GIRD's basement? And it is also probably the reason, don't you think, that grey-haired GIRD veterans, a little group of no longer young people, winnowed by the sieves of war and hospitals, get together so often today?

Years later Prof. M.K. Tikhonravov, D. Sc., Hero of Socialist Labour, Honoured Worker in Science and Technology, explained the birth of GIRD as follows:

> 'In the Thirties the outlook for the development of aviation had become clearer, and the limits of the airscrew had begun to be apparent. In looking for ways to get around these limitations a number of young aviation workers concentrated their attention on the problems of reaction propulsion, adopting Tsiolkovsky's ideas not so much because of a desire to fly to Mars as because of the general striving to fly higher, faster, and further. Apart from their dreams and aspirations, these men already had experience of work on aircraft construction, had aircraft of their building behind them, and thought-out designs and ideas in rocket engineering. These people could rely on the aircraft industry as a real base for work on jet flying apparatus. And it was from these people that the head of GIRD came, S. P. Korolev, in whom were combined outstanding talents as a designer, and profound scientific intuition, and brilliant organizational capabilities.'

And yet a desire to fly to Mars had already been kindled in each of them, and it was this romantic zest for the extraordinary that had brought them to this strange organization that at first did not even pay them but demanded much work, did not issue ration cards, and took a whip-round to get the money to buy cutting tools. Outwardly the im-

pulse was very different. For one it was a brochure by Tsiolkovsky that he had come across by chance; for another it was the excitement he felt after a lecture by Zander at the Polytechnical Museum; for a third it was insatiable curiosity. Johnathan Swift wrote long ago that the cause of great deeds, like the source of a great river, is often very small.

It was a paradox, but the strength of GIRD lay in its weakness; no one expected material benefits of any kind, no one came to 'make money'; everyone understood that the jests about 'lunatics' would not end tomorrow, that this business would not bring fame, and that you could not make a career in it. It was no place for money-grubbers or thrifty souls, or people carefully building themselves a career. There was nothing there but interesting work.

And they worked.

V. A. Andreev, the designer, arrived one morning and saw Zander sitting over a pile of papers. When he noticed Andreev, Zander inquired absent-mindedly: 'What! Is the working day already over?'

After that Korolev issued a verbal instruction to the effect that the last group leader to leave should take Zander with him.

The welder, A. A. Vorontsov, welded an iron frame, and went home at eleven p.m. At two a.m. the designers S.S. Smirnov and Lydia Kolbasina saw that the frame needed to be re-made. They went to Vorontsov's place, woke him up, took him back to the basement and finished the work by morning.

Yakov Golyshev, an engineer, broke his leg at the skating-rink and had to stay at home. Every day his mate Andrei Salikov brought him calculations to make.

When the book-keeper said to the girls that did the copying, 'What do you stay here every evening for? I won't pay you a kopeck's overtime,' the girls answered, 'We're

staying because we want to, not for the sake of the accounts department!'

The trade union commission fighting against overtime paid a surprise visit to GIRD, but could do nothing. There were all sorts of explanations.

'I'm making up time spent on personal business.'

'I'm finishing a piece I didn't get done in the agreed time.'

'This is my own chart. I'm drawing it for myself.'

Evgeny Moshkin, a constructor, was expelled from the Komsomol because he missed two meetings. That was because he worked every evening at GIRD. When he was summoned to attend the Komsomol committee Moshkin said nothing; GIRD was a secret organization, and he could not disclose where he had been.

Yes, there was secrecy, and passes, and a porter at the door. Self-sacrifice and youthful enthusiasm unwittingly create an impression of jolly anarchy, and gay mateyness, but Korolev, by means known only to himself, very soon succeeded in moulding GIRD into a serious institution, both in purpose and in form. There were plans and instructions, in-trays and out-trays, and a receptionist-secretary, and for personal matters with the chief you had to apply in writing for an appointment. There was no back-slapping, no familiarity. Some addressed each other by Christian names, but the heads were all addressed formally, only the girls, whispering to one another, might call Pobedonostsev 'Yura dear' and Korolev 'Sergy-boy'. The leaders, in their turn, never called subordinates by their first names, unless they were personal friends. It would not seem to be important, how people were addressed, but it illustrates the world of human relations in GIRD, in which youthful enthusiasm was beautifully combined with discipline and respect. Korolev invariably used the recipe of this psychological mixture, always and everywhere.

Most of the people at GIRD, including Korolev himself,

worked there at first in the evenings on a voluntary basis. The first group in the basement was quite small—a dozen or so people, but it grew very quickly. From his Kaluga remoteness, Tsiolkovsky unexpectedly, like Captain Nemo, rendered the new initiative great service. On the last pages and the covers of his booklets he used to reprint the most interesting letters he had received. In his *The Semi-rocket Stratoplane* he reprinted the letter from I. P. Fortikov that informed him about the setting up of GIRD in Moscow. In this way Tsiolkovsky's readers—the very people who needed GIRD and whom GIRD needed—learned about it. Toward the spring of 1932 its nucleus had taken shape: F.A. Zander, S.P. Korolev, M.K. Tikhonravov, and Yu.A. Pobedonostsev. Zander brought a very talented engineer A. I. Polyarny with him from the Central Institute. Leonid Korneev, a student, went to see Zander at the Institute to tell him about a recent visit to Tsiolkovsky and found himself one evening in GIRD's basement. Korolev induced his former acquaintances with whom he had built gliders and worked in the Central Bureau and Central Institute, N.A. Zheleznikov, and A.V. Chesalov, to come and join him. V.N. Galkovsky, E.M. Matysik, and V.A. Andreev had already been working at Korolev's home, and it is little wonder that they, too, joined GIRD. In that way the basement was gradually tenanted. This is far from a complete list of the staff of GIRD, but then it had no establishment. With everyone wanting to work at GIRD Korolev had a lengthy talk in Nikolskaya St., where the section for mass-organizational work was located. Korolev would find out who he was, what he could do, where he worked, and why he wanted to work on rockets. He always asked about pay, and frankly warned them: 'You won't get as much here'.

Veterans recall that slanderous tongues said GIRD stood, in Russian, for 'Group of Engineers Working Without Benefit', implying that no money was paid and that the results were useless. But that was not true. They were unpaid

only during the period when GIRD was a purely voluntary, 'amateur' organization; after Osoaviakhim had given it official status and begun to take an interest in it, they were paid, but their pay was very low, much below that, for instance, at the Central Institute. And as for ration cards for food and other things, there were also many difficulties. Sometimes ration cards were not issued at all, and sometimes five-day cards, like those for people travelling on official business were issued. But it never occurred to anyone to demand anything from Korolev, and if a murmur of discontent was heard it was always directed against the supply organization.

They had to start literally from scratch; all the equipment consisted at first of a hand grinder that friends at the Central Institute gave them. The production chief of GIRD, G.P. Bekenov, recalls:

> 'For equipment or materials, or for anything else we had neither ceilings, nor funds. But still... .
>
> 'At first we brought what we could from home: hammers, files, pliers, saws, and so on. Later, thanks to the resourcefulness of the leadership, that is to the chief, S. P. Korolev, we managed to get everything we needed... .
>
> 'As work progressed a need arose for a small Komsomolka lathe. Lack of one was holding everything up. Factories more and more frequently refused to respond to any requests to make small parts. But try as we would we could not get a lathe. And then one day we assembled in Korolev's office and he said:
>
> '"Look, friends, suppose we go to the office of some top-level chief in this tunic (we then wore Osoaviakhim tunics) with the traces of pips* on the tabs? The

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* In those days the badges of rank of commanders of the Red Army, red rhomboids, were worn on the gorget patches of tunics.

conversation would probably be different, eh? Patches have weight!"

'Three days after this talk I came out of the People's Commissariat for Heavy Industry with my soul overflowing with happiness. In my hands I had the papers to get a Komsomolka lathe and on the faded tabs of my tunic the outlines of pips.'

L.K. Korneev, now a senior engineer, but then leader of a group at GIRD, describes the following episode:

'We were completing production of a rocket motor with cooling vanes, some of the parts could only be soldered with silver. We had no silver and there was no money on GIRD's till. How were we to get on? What was to be done? No one lost heart because of that, though. The next day, without any mention to each other, many brought silver from home: one a silver teaspoon, another a crucifix, another a silver thimble. All these silver 'details' were immediately melted down in a crucible, the chamber was soldered and passed its hot tests well.'

Korolev understood that the supply problem could only be solved by breaking the vicious circle: no instruments and materials—nothing to work with—plans not fulfilled —no results. So it was not clear why tools and materials should be released, or whether they need be released at all. It was necessary, cost what it may, to produce results, to convince others that the game was worth the candle, and that all their plans were really serious.

In January 1932 Korolev, Zander and Pobedonostsev discussed in details how to install the OR-2 engine on a glider and made arrangements for Cheranovsky's BICH-11 tailless glider to be transferred to GIRD. The glider with the trapezoid wing was delivered to Korolev in February,

and immediately was given a new name RP-1—rocket glider one.

But it was a long way to its flight. Despite Zander's colossal capacity for work, there still was no engine. Korolev hustled him, but he knew that it would take weeks and months to convert the glider into a rocket plane. Even Zander could not cope with the job single-handed. Specialists were needed; not enthusiasts of interplanetary flights ready to blast off for Mars without a tremor, but men who knew how to assess heat flux and calculate the pressure losses in hydraulic systems. Korolev saw clearly that if the need for learned men was so urgent today, what would it be like tomorrow. A letter went from GIRD to Tsiolkovsky in Kaluga:

> 'Wouldn't you agree to be our consultant?... Send me as many of your valuable booklets as possible and you can rest assured that they will be put into the hands of people who are dedicating their energies to the cause you so brilliantly initiated 37 years ago... . Do not condemn us for forcing the pace and for not following your wise advice about working step by step.'

Prof. N. A. Rynin came down from Leningrad, and on 28 November 1931 read a major lecture to an audience at the Air Force Academy. Its title was 'Reaction propulsion'. It was illustrated by many slides. But one swallow did not make a summer. At the beginning of 1932 Zander and Korolev organized special courses in rocketry for engineers and constructors. Zander drew up a detailed plan of studies. Korolev persuaded the best specialists to read lectures. Classes were held in the premises of the aviation section of Osoaviakhim on what is now Kuibyshev St. V.P. Vetchinkin read a course in aerodynamics. Prof. B. S. Stechkin talked about his latest work on the theory of jet engines in a course that became the guide for designing the first Soviet

jet engines. Other lectures were read by B.M. Zemsky, N. A. Zhuravchenko, and V. V. Uvarov.

Korolev was satisfied; this was already something more solid than a shop-window on Gorky St. with a lunar landscape! He paid extraordinary attention to the problems of propaganda for, and popularization of, rocketry. The books and articles about interplanetary flight and life among the stars had done their job; they had attracted attention and aroused interest. GIRD meant a new stage in the progress of rockets and now it too needed new books and articles to mould public opinion in the direction most favourable for this progress. The importance Korolev attached to this is evident from a letter he wrote to Yakov Perelman at the end of July 1932:

> 'Dear Yakov Isidorovich!
>
> 'Forgive me for such a long silence, but I am so busy that I haven't a free minute.
>
> 'Despite the heavy load of our various experimental jobs we are all very much concerned about the development of our mass work. For it would undoubtedly be quite wrong to base everything solely on the military, top secret side of the business. In this respect the development of our Civil Air Fleet can serve as a good example. Only 1.5 to 2 years have passed, but how broad the scope of its activities has become, and what a solid public image has been created! Therefore we must not miss the bus, but must accept and direct all the vast local initiative so as to create a definite positive public opinion around the problems of reaction propulsion, stratospheric flights, and, in future, interplanetary flights. And of course we need literature above all. There is nothing except for two or three books, and they are not available everywhere.
>
> 'We think that the publication of a whole series (10-15) small popular booklets on jet propulsion would be quite timely, with each book devoted to some one

problem, for instance: "What is a Rocket Motor", "Propellants for Rocket Motors", "The Application of Rocket Motors", and so on. They should be popular books and at the same time technical. In future they could be superseded by a more specialized series.

'In general, too many things of all sorts, complex and simple, and all kinds of calculations have been written here about how an interplanetary ship will approach the Moon, and what will happen to it on the way, and so on, but there is absolutely nothing for the member of a GIRD circle who is dying to learn and to work. In a letter one has to write very briefly, but I know that you will understand my idea. I would very much like to know your views on the matter and the concrete form that you think such literature should take. Who it should be mainly intended for, the themes, size, etc. Would you, perhaps, agree to take part in this work and write something?

'You probably know about the proposed celebration of Tsiolkovsky's jubilee. When it will take place exactly, I do not know, but there are still people who contend that it is pointless to celebrate it because, they say, it would place all the R.P. workers in a ridiculous position and so on, and that there should be no celebrations, and so forth. Unfortunately, all that is being said by people who carry too much weight for their words to be ignored.

'GIRD's opinion on this matter will be decisive, and for that reason I would very much like to know Leningrad's opinion, and in particular yours... .

'The question of convening an All-Union congress on R.P. is now being raised, but I am not at all clear what should be the problems and tasks of such a congress. Isn't it premature?

'All the best

Most sincerely yours, S. Korolev.'

In this letter Korolev alluded briefly to the possible applied side of the job he was engaged in.

For all the scepticism towards rocketry in those years, there were people who could picture its great future and who did everything possible to bring that future closer. One of them was M. N. Tukhachevsky.

Tukhachevsky's appointment as commander of the Leningrad Military Area in May 1928 played a major role in the organization of research in the field of rocketry. The Gas-dynamics Laboratory (GDL) set up in June of that year under the auspices of the Military Research Committee of the Revolutionary Military Council of the USSR was always under Tukhachevsky's scrutiny, who carefully followed all its successes and failures. The order of 25 July 1930 confirming the transfer of the GDL to the military establishment was of course not issued without his knowledge.

On 19 June 1931 Tukhachevsky was appointed Deputy Chairman of the Revolutionary Military Council in charge of armaments for the Red Army. Immediately, on 15 August 1931, the Leningrad laboratory was put under the Chief of Staff (Armaments) which in fact put it under Tukhachevsky.

In Moscow Tukhachevsky learned of the formation of GIRD. He realized that this new affair should be supported, but it was more difficult to take it under his wing than it was with the GDL. The Gas-dynamics Laboratory had developed historically as a military organization. In 1921 N.I. Tikhomirov had already begun work in Moscow on rocket projectiles with smokeless powder under the auspices of the War Department. GIRD was rooted in Osoaviakhim, and it wasn't quite proper to rob Osoaviakhim of a group that it had only just set up. Tukhachevsky had a different plan: not to take GIRD away from Osoaviakhim, but to change its sign and to set up a real scientific centre on its basis.

From the end of 1931 Korolev maintained the very close

contact with Tukhachevsky, who immediately appreciated the extraordinary energy of the young leader of the Moscow rocket people. That was also when the idea of setting up a scientific centre—a jet institute—was born. The idea began to develop in 1932 and to assume concrete form. On February 1 1932 the Air Force Board of the Red Army heard a report on GIRD. There is a short note in Zander's diary for 1932: 'Went to Com. Tukhachevsky's meeting', which refers to the big conference on the development of rocketry held at the Revolutionary Military Council on March 3rd to which Tukhachevsky, who presided, invited not only the commanders of the arms (aviation, artillery, chemical warfare, etc.), but also representatives of Osoaviakhim. The leading people from GIRD and comrades from the GDL were present. Korolev made a report, which was followed with approving attention, and Tukhachevsky then had no difficulty in putting his plan into operation; the conference passed a resolution urging the creation of a research institute for reaction propulsion that would become the top organization in the field of rocketry. The proposal was warmly supported by the Leningraders. A memorandum of the Leningrad GIRD dated 8 April 1932 and signed by V.V. Razumov, N.A. Rynin, M.V. Machinsky, Ya.I. Perelman, B.S. Petropavlovsky, and others, expressed a wish for such an institute to be set up. The Gas-dynamics Laboratory was working at the same time on the draft charter for a Gas-dynamics Research Institute.

Things were moving. At the end of April Tukhachevsky submitted his proposals for setting up a unified rocket centre to K.E. Voroshilov. After discussion of his report it was decided to put the question before the Council for Labour and Defence. Tukhachevsky presented a detailed report on the new institute to the Chairman of the Council on May 16th, together with a list of the problems that it would have to deal with, and an estimate. In this report Tukhachevsky, looking a quarter of a century ahead, noted

that in artillery the rocket principle provided unlimited possibilities for firing artillery projectiles of any power to any distances, and that in aviation it would 'lead to a rapid increase of flying speeds and raise the ceiling of aircraft to the stratosphere and in the last analysis resolve the problem of flight in the stratosphere'. He also spoke highly of the work of GIRD and of the GDL, saying that 'the results of the work of these organizations already give every ground for concluding that there were serious prospects of using reaction propulsion for practical military purposes. But the funds, the facilities, and the methods of work of the GDL and GIRD are not adequate in their present form for very quick and full solution of the jet problem in the context of its practical application for military purposes. On the basis of existing achievements it is necessary to set up at all speed a broad scientific and experimental base in the form of a Jet Institute or some other research establishment to continue this most important work'. Tukhachevsky even proposed 'including the building of the Jet Institute in the list of shock projects'.

On 22 June the Defence Commission referred the proposal to another special commission, which also included Tukhachevsky for review. There was nothing to consider as everything was clear, and on 5 July this special commission submitted its resolution on the organization of the institute to the Labour and Defence Council. Twenty days later the resolution was returned for re-drafting. Now it was necessary to consider construction problems, time-tables, and appropriations. To gather an augmented commission of extremely busy people who did not, in addition, fully realize the importance of the problem was difficult. Matter bogged down.

Having foreseen such a possibility Mikhail Tukhachevsky had already, during the March conference at the Revolutionary Military Council, raised the question of providing a production base for rocket research, christened 'Experi-

mental GIRD Rocket Works'. The order setting it up was signed by the Chairman of the Osoaviakhim Central Council, R. P. Eideman on 25 April 1932. That day is sometimes taken as GIRD's birthday although by that time the newly-born infant was already standing on its own feet, even if it was still unable to walk.

The experimental factory was that same basement in Sadovo-Spasskaya St. Outwardly nothing was changed, except that it now became easier to obtain supplies; say what you like, it was a factory.

The cellar is still there. Worn iron steps lead you to a long corridor. Much has now changed, and much has been rebuilt, but even now one has no difficulty in imagining the creaking door on the right, where the workshop was. The long awaited Komsomolka lathe was little by little supplemented by other machine tools, old and worn out, but still machine tools. Nearby was a hand-operated forge, and further along the corridor were the so-called laboratories where people worked with the phosphorus and tried igniting metal propellants. To the left of the stairway were the staff rooms. Only Korolev had a personal office, with a tiny waiting room. The others shared rooms with their teams.

Korolev undoubtedly had the rare gift of selecting people and putting them in the right jobs. Later, in his 'space' years, when anything went wrong he would say: 'Let's change places', meaning by that a variant in the disposition of forces. The structure of GIRD was his first independent go at organization, and it already showed the hand of a master.

GIRD was headed by a technical council, a collegiate body consisting of the leading specialists and deciding all general problems. Its members were Korolev himself, Zander, Tikhonravov, Shchetinkov, Korneev, Pobedonostsev, Chesalov, Efremov and Zheleznikov. The group for studying reaction propulsion was divided into four teams, each headed by a leader with several engineers under him and, very important, mechanics, whose permanent and

well-defined responsibilities enabled them rapidly to improve their skill.

The first team was led by Zander. His principal assistants were Korneev and Polyarny. Their main concern was to develop the OR-2 engine and to create a liquid-propellant rocket.

The second team was headed by Tikhonravov. He was six years older than Korolev, had gone straight from the Army in 1920 to the Institute of the Red Air Fleet (later re-named the Air Force Academy) and had been one of its first graduates. Since 1927 he had been working in various aircraft factories and had built gliders with A. A. Dubrovin and V.S. Vakhmistrov. Korolev had met him in Koktebel. Later they had worked together at the Central Design Bureau. One day Tikhonravov, who was already working on jet propulsion on his own initiative, heard about a secret rocket organization in Leningrad, the GDL. He could not work out what the letters stood for and presumed that the 'L' stood for Leningrad. He wanted very much to work on rockets, but did not know how to get in touch with the mysterious GDL. And just then he met Korolev who told him about the GIRD idea.

'Don't forget, I want to work with you,' he said.

'Excellent!' beamed Korolev. 'We already have Zander, Pobedonostsev, and Chesalov. We're looking for premises. You should look too. A church would be best—thick walls, they're better for explosions.'

Tikhonravov was one of the first to come to Korolev's basement. His brigade included such talented engineers as V.S. Zuev, F.L. Yakaitis, and N.I. Efremov (who soon became the GIRD party organizer succeeding Korneev). This team worked on liquid-propellant rockets.

Pobedonostsev became the leader of the third team. He, too, worked at the Central Institute and was interested in gliders. He had been inspired by Yakov Perelman's books, and soon after meeting Zander and Korolev became one of

the most ardent and impatient rocket enthusiasts. The Central Institute categorically refused to let him transfer to GIRD. Then he got himself called up into the army and was posted to an infantry regiment, from which, through Tukhachevsky's intervention, he was seconded to GIRD to continue his military service there. Pobedonostsev was in charge of a team at GIRD, but was considered a rank-and-file soldier and received a Red Army man's rations. The engineers working with him were V.E. Lisichkin, V. A. Timofeev, M. S. Kisenko, and G. I. Ivanov. They worked on powder-propelled rocket projectiles, ram jet and pulse jet engines.

Finally, Korolev himself was head of the fourth team. Working with him were E. S. Shchetinkov, A. V. Chesalov, and N. A. Zheleznikov. Their main project was the RP-1 rocket plane.

Korolev was very keen on the rocket plane. The BICH-11 glider was comparatively small, 3.1 metres long with a wing span of 12.1 metres, and weighing only 200 kilograms. Korolev drew up a programme of test flights for the RP-1 before the rocket motor was installed. It was simply that he was very eager to fly the glider and it was easy to give the flights a 'business-like' look corroborated by documents. He made a detailed report on each flight.

An entry in Zander's diary for 22 February 1932 reads: 'Took part in flights of the RP-1 plane.' Korolev had dragged Zander out to Pervomaiskaya Station, where the aerodrome of the Moscow Flying School was located, in order to demonstrate his flying skill.

The glider took off from the ground with difficulty, even after the ballast—a bag of sand—was removed from the nose. Korolev flew nine times, not getting higher than ten metres, made turns, and was perfectly happy. Zander froze and could not, for the life of him, understand why he was there.

In the spring Korolev made two more flights with the aid

of a catapult, and then had the idea of trying to fly the RP-1 with a piston engine. He found a very dilapidated twin-cylinder Scorpion engine, designed an engine frame with Shchetinkov and had the mechanics mounted the engine on it. He rented a hangar near Trikotazhnaya Station not far from Khimki, and began testing. The first attempt to take off was a failure; the plane did not budge, although the engine was full out. The engine was assisted by a rubber catapult, then by two, with twenty men pulling as hard as they could. Korolev's report said that 'the moment the plane got off the engine stalled'. At last it managed somehow to take off and staggered along for half a kilometre at an altitude around five metres, and then glided to make a soft landing on a wet meadow.

Korolev was not satisfied. That week he tried twice more to lift the RP-1 and engine into the air. But there was a hoodoo on the Scorpion; it worked well on the ground, but as soon as Korolev lifted the plane, literally a few centimetres off the ground, it stalled.

Only one conclusion, apparently, could be drawn from these tests: the Scorpion was no good as the engine, but the analysis of the glider's behaviour in the air and the incident with the ballast made Korolev look again at certain important problems of its construction. In an article 'Data for Calculating Weights', published in the *Aeroplane*, Korolev wrote: 'The constructor's main task is the closest possible adherence to the planned weights during construction.'

This aspiration of 1932 became a slogan and the law in the Sixties, when spaceships and interplanetary stations were being built. It was as if he was then writing for future constructors of the *Vostok* and *Soyuz* space vehicles:

> 'Metres of cable, dozens of rollers, bolts, screws, rivets, etc., in a glider, numerous tubes and pipes, valves, nipples, instruments, etc., in a plane—all

add up to kilograms and kilograms of weight that suddenly shows up "unexpectedly" when the machine is already ready.

'...No estimating "by eye", if they are relied on, will ever guarantee that the constructor will get the weight of machine in practice that he planned.'

Amid all the cares of GIRD Korolev found the time to go to Leningrad to see how they worked at GDL. In March the Leningraders came to Moscow and visited GIRD's basement. Zander had a long talk with Valentin Glushko—the designer of liquid-propellant engines at the GDL. In Leningrad they were already experimenting with LPE's on a broad scale with many models. But Korolev was more interested in the experiments of another member of the Gas-dynamics Laboratory, V. I. Dudakov, who was experimenting with powder-fired boosters on aircraft, than in Glushko's work. This had something in common with the rocket glider, and he was very eager to find out what were the prospects for solid-propellant rocket motors, and whether or not he was mistaken in staking everything on the OR-2.

The Leningraders were established in a historic place, in the St. John ravelin of the Peter and Paul (Petropavlovskaya) Fortress. There, under the heavy stone arches, Glushko's liquid-propellant engines roared. Dudakov was fixed up at the Komendantsky Airfield. A TB-1 bomber had been assigned to him and he had installed boost motors on it. Korolev flew in the plane to test everything himself.

Dudakov's work was undoubtedly very promising. It enabled loads to be increased and greatly reduced the run needed to take off. But that was not the same as a rocket glider. These were boost motors, and Korolev needed an engine. On his return to Moscow he gave Zander more active assistance.

Zander had finally settled in the basement just before the May Day holiday. At the end of May he spent several

evenings discussing plans for future work with Korolev. The latter nodded in agreement, and only when Zander proposed buying a diver's suit did he start arguing.

'No, there's no money just now for a suit.'

'But look you,' Zander came back, 'we'll need it all the same. Our rocket may come down on water. How are we going to recover it?'

Korolev realized that it was not a matter of a diving suit. Sooner or later they would have to think about a pressure suit for stratospheric flying. So he promised to buy the suit, with one proviso—when the rocket was ready.

Zander spent the whole summer in the basement, luckily it was not hot there, leading the work of his team, preparing the OR-1 for testing, and making the last calculations for the OR-2. When he sat at his ancient typewriter, or with his big half-a-metre slide-rule, he had the knock of cutting himself off entirely from the outside world; he saw nothing, heard no voices, and completely lost all sense of time. It seemed to many people that his pale face lit up when he was working.

After the final corrections had been made to all the plans the members of GIRD were invited to a meeting with R.P. Eideman on 10 July 1932 at Osoaviakhim. The belated order, many sections long, of July 14th, in which Korolev was appointed head of GIRD, was actually the result of his report on this occasion to the Chairman of the Central Council of Osoaviakhim.

Reports of the marvellous flight of Auguste Piccard with his assistant Max Cosyns into the stratosphere spurred Korolev's impatience. Piccard had taken off near Zurich and after reaching 16 201 metres had landed in Italy. Between the end of August and the beginning of September Korolev tried a second model of RP-1, this time without an engine. Incorrectly adjusted rudders prevented him from getting higher than four metres. The rudders were corrected, but this time the glider stalled. At last everything was put

right, and Korolev and then a pilot, Romanov, succeeded in getting up to 40 or 50 metres, a very modest result; but Korolev was satisfied. 'RP-1 No. 2 without an engine,' he wrote in his routine report, 'possesses every kind of stability and maneuvrability.'

In September Korolev and his wife went to the Crimea. After their marriage Lyalya had not been allowed for a very long time to move to Moscow, and Sergei had even been forced to go to the Donbas again to kick up a row. She had finally moved to Moscow in December 1931. They lived in the Balanins flat in Alexandrovskaya St., in the old 'home design bureau'. Sergei's mother greeted her daughter- in-law cordially. She had known her for seven years, and had always liked her.

During the winter it was rare when Sergei spent an evening with his young wife—he now had so much to do. But he promised her solemnly they would go to the Crimea together in the summer, come what may! The trip was repeatedly postponed, what with the urgent business at Osoaviakhim, and important meetings, and conferences, and flying of the new RP. They left for Sevastopol only in September. How was Lyalya to know that these delays were an innocent gain for Sergei: the 8th All-Union Glider Rally was to open in Koktebel on October 10th.

Great importance was attached to the eighth rally. It was not only a sports competition, but a political event. Osoaviakhim, the Young Communist League, and the trade unions had taken a special decision to promote gliding in order to make it the 'mass air sport of the workers'. People's Commissar Voroshilov said in his message to the rally: 'The competitions in Koktebel will emphasize the enormous importance of gliding for the training of courageous, bold, resourceful air fighters.' Greetings were also received from Eideman, the Chairman of Osoaviakhim, and the Commander of the Red Air Force Ya.I. Alexnis, a member of the Revolutionary Military Council. For the first time a spe-

cial bulletin *Plane at the 8th Glider Rally* was published in Feodosia.

Twenty two gliders were brought to the rally, many of them quite new, previously unknown. The names of young constructors from Kharkov and Saratov were mentioned. Vasily Stepanchonok again became the hero of the rally, the press calling him the best glider pilot. This time he flew to Koktebel from Moscow in a G-9 glider, towed by a U-2 plane piloted by the glider constructor V.K. Gribovsky.

Korolev flew his Red Star, but did not establish any records; in fact, he had no intentions of doing so. He simply wanted to fly and to see his favourite places again. But after only a few days Moscow began to pull him. Now he had his own job in Moscow, and he could not forget it either in Sevastopol, or in Koktebel. Neither the sun and sea, nor the expanses of the Crimean steppes spread out below him, could distract his thoughts from the basement in Sadovo-Spasskaya St. One evening he suddenly said to Lyalya: 'Let's go back to Moscow tomorrow, eh?'

CHAPTER 18

When Tsiolkovsky was invited to Moscow he always refused, pleading indisposition, weakness, age, or deafness but, like Newton, he was simply a confirmed home-body. Any journey frightened him, the thought of hotels terrified him, and he recoiled from the idea of all frightful unaccustomed life when you don't know where and how you are going to eat or what you are going to sleep on. That was why the ceremonies held in Moscow and Leningrad to mark Tsiolkovsky's 75th birthday were celebrated without him; despite all efforts to persuade him to attend, Tsiolkovsky stayed at home. But at the end of November he had to come and in the Kremlin M. I. Kalinin invested him with the Order of the Red Banner of Labour. Tsiol-

kovsky was very moved. Having received the Order he said in a low voice, almost confidentially, to Kalinin: 'I can thank the Government only by my work. Gratitude expressed in words is meaningless'.

Korolev saw Tsiolkovsky every day the latter was in Moscow and talked with him. But each time Korolev began talking about effective help for GIRD Tsiolkovsky switched the conversation to his booklets and articles and again complained of weakness and old age. He was, indeed, already a very old man, and Korolev realized that Tsiolkovsky could no longer help them except with general advice and the authority of his standing. Korolev invited him to visit the basement, but Tsiolkovsky did not come.

But it was visited by Tukhachevsky. It was both an informative visit and a kind of inspection; since August 1932 the Department of Military Inventions had been paying a subsidy to GIRD. Osoaviakhim was only too glad; Tukhachevsky was 'richer' than Eideman. Korolev warned everybody about the visit of the Deputy Peoples' Commissar and gave them to understand that they must put on a show. When Tukhachevsky together with the officers of the Department accompanying him came down to the basement everything looked extremely business-like. Heat engineers sat over their calculations in clean well-ironed shirts, the forge blazed, the machine tolls hummed, everything that could clatter and shine clattered and shone. It was noisy and stuffy. Tukhachevsky already knew from Korolev that the basement was not very suitable for the work, but quite frankly he had not expected to find it so crowded. He visited all groups, looked at their diagrams and graphs, and at the drawings for the 07 rocket, attentively and patiently listened to the explanations, asked questions about the working of the oxygen pump and the engine stand. It was evident that he could read blueprints. He instantly grasped the general idea and when he didn't understand something he immediately asked questions.

Zander told him about the OR-2 engine and then, forgetting Korolev's warnings, began talking about his cherished dream, Mars. Tukhachevsky listened very seriously and then said: 'Yes, yes, flights to the planets won't be very soon, but we'll have to think about it.'

Tukhachevsky was satisfied by his inspection and promised to help organize a test site; the basement was clearly unsuitable for experiments. He wrote the following letter to the commission in charge of the implementing Tsiolkovsky's inventions:

> 'In Moscow, within Osoaviakhim's system, an organization called 'MosGIRD' is working. A special group of engineers of this organization is working intensively on designing rocket engines with liquid fuel, with some of them already in blueprint stage, ready for urgent construction. This work, connected with K. E. Tsiolkovsky's inventions in the field of the rocket and interplanetary communications, is of great importance for the Military Department and the USSR as a whole.
>
> 'Because of the special features of rocket engines it is absolutely necessary for MosGIRD to have a small experimental machine-shop for making them.
>
> 'I ask you... to take all steps to bring public influence to render MosGIRD real help as regards obtaining equipment for it from the People's Commissariat of Heavy Industry. MosGIRD, of course, being unknown organization, has been unable up to now, despite the steps taken, to obtain the equipment.
>
> M. I. Tukhachevsky,
> Deputy People's Commissar for the Army and Navy,
> Deputy Chairman, the Revolutionary Military Council of the USSR.'

But Tukhachevsky knew that a few extra machine tools in GIRD's basement was only a half-measure. On 10 December 1932 he again spoke of the need to set up a rocket research centre and asked for a decision to be speeded up.

Once more December was the beginning of busy times for GIRD. A week before New Year the assembling of the long-awaited OR-2 motor was at last finished. Korolev, Zander, Korneev, and Polyarny, the engineers, Florov, the mechanic, and Avdonin, the fitter, signed the acceptance papers with all the solemnity of diplomats. Testing could begin. It is hard to say who was the more eager to start them: Zander, who at last saw his dream embodied in metal, or Korolev, who had already been waiting for it for his rocket plane for more than a year. Anyway, this event was really a holiday for all the tenants of the basement.

A general meeting decided to declare a crash week. A staff of three was set up to organize it and drew up a plan of what everyone was to do.

From December 25th to New Year's Day they worked day and night, busied themselves with the whimsical motor. They wanted so much to have it working by January 1st that they didn't even think of celebrating New Year's Eve. But things did not work out.

The engineers and the mechanics were still inexperienced. Leaks developed in the joints of the safety valves and of the T-joint. A crack was suddenly found in the petrol tank. Then the connections of the nozzles of the left oxygen tank began leaking, then the throw gear of the petrol tank began whistling. Every day something new went wrong.

It was a dismal New Year's Eve.

On January 2nd, as the mechanics were preparing the OR-2 for new tests, Zander finished 'Technical Description of a Powerful Rocket Engine', his plan for the future, and handed it to Korolev.

The next day the OR-2 was again tested. And suddenly everything went splendidly. Pressure was maintained. Then

the circulation of water in all the tubes was checked with a centrifugal pump. Everything was excellent! The New Year was proving to be happy!

On January 5th a gas leak was again discovered, then the valves began leaking, then the tank began deformed. And so it went all through January. Zander walked about grey with fatigue. Sometimes, seeing everyone exhausted, he would start talking about interplanetary flight and the long road to Mars. He talked quietly, but with such passion that they listened to him with bated breath. Korolev liked the minutes of these lulls. Once he asked quite seriously: 'But why are you talking all the time about Mars? Why not about the Moon? It's much nearer.' Everyone exchanged glances. Korolev seldom spoke of interplanetary flight.

Sometimes Zander forgot all about his family. Then he was forced into his leather coat with the fur collar and sent home. But even if he was taken as far as the tram stop he would manage somehow or other to creep back into the basement. Korneev wrote in his reminiscences:

> 'All of us at GIRD literally worked 24 hours a day. I remember how, for three days running, we couldn't get a vital test ready. All the members of the group were younger than Zander, and it was much easier for them to stand such a strain. Seeing that Zander was very tired and asleep on his feet we presented him with an "ultimatum": if he didn't go home immediately everyone would stop work, but if he went and had some sleep everything would be ready by morning, and when he got back he would be able to start testing. No matter how much he argued and protested against going, the group was adamant. Soon, without anyone noticing, Zander disappeared, and the group began working even more intensely. Five or six hours passed, and one of the mechanics shouted loudly, not without solemnity: "Everything's ready. Raise the pressure, we're off to Mars!"

'And suddenly everyone was stupefied. A couch that stood at the far end of the basement toppled with a crash, and from behind it appeared Zander. He threw his arms around us and hugged us, and then told us, laughing, that he had hid behind the couch and watched the work from there, and because he felt bored sitting there he had managed to finish some calculations and had had an excellent rest.'

In addition to the OR-2 engine experiments they were also testing the engine for a liquid-propellant rocket. Already in this first rocket Zander wanted its metal parts to break up and be burned in the motor. Experiments had been started with a powdered metal fuel. Korneev and Polyarny ground aluminium and magnesium in special mills. The powder was supposed to be passed into the combustion chambers through injectors, but its flow was uneven, it sintered and burned the chamber. It was clear to everyone, except Zander, that it would not be possible to equip a rocket with grinding mills, that it was not feasible to reduce the metal parts to powder, that even if it were, there was still the problem of how to burn it; and that nothing would come of the idea of metal fuel.

Korneev and Polyarny begged Zander to drop the idea and to simplify the system of feeding liquid fuel to the motor, but he categorically refused. They tried complaining to Korolev, but he kept silent and did not contradict Zander. They never argued though they both liked arguing, and Korolev, who could shout at anyone, when in a temper, never shouted at Zander.

Zander looked very tired, lost weight, and became haggard. They soon noticed that he took the cheapest dishes in the canteen where they ate. Korolev suggested a whip-round and to pay for Zander secretly, in advance. Zander continued to pay his seven kopecks, but received dishes for 35 kopecks. There was no end to his rejoicing: 'How

much better the food has become in the canteen!' E.K. Moshkin, who was a vegetarian, gave him his meat ration. Zander accepted with gratitude. He brought thin porridge with him from the canteen in a tin with a wire handle for the evening meal, and stored crusts and bits of dry bread in a drawer. Sometimes he would pull the drawer open, look inside, and say with a smile: 'There's been a mouse.' And sometimes, he would exclaim with astonishment in his voice: 'Oy! Where I get this cutlet?'

Korolev ordered tea and sandwiches to be brought to Zander every evening.

Korolev was twenty years younger than Zander, but it looked in practice as if it were the other way round. He sort of adopted Zander. And he got him a warrant to go to Kislovodsk to a sanatorium.

Zander was seen off on March 2nd. He did not want to go; the hot tests of his motor were to start very soon. Tukhachevsky had kept his word and they now had their own experimental base, the 17th sector of the scientific experimental testing grounds in Nakhabino. Zander was eager to see how his OR-2 worked. But Korolev persuaded him to go. 'Make the trip and go away. What's there in bench tests? Who are you and we going to impress with bench tests? When you come back we'll install the engine in the tailless glider, and fire your rocket. That will really be something. That's absolutely necessary for it to fly; anyone can manage on a stand.'

Zander left. The first tests of the OR-2 began on March 13th. Something went wrong with the feed system, and the engine did not fire. On March 18th it worked. And in a few seconds the nozzle burnt out.

On the eve of the first tests in Nakhabino Zander sent his daughter and wife a post card from Kislovodsk.

'My dear Astra and Shura!
'I'm living quietly at the sanatorium. It has snowed

again here, there's little sun, and a light frost. There are still no flowers anywhere except under glass of the winter garden. The animals in the park are all alive. Four bears play about, and seven beautiful peacocks display their tail feathers.

'They are feeding us marvellously, four times a day. I get increased rations with much butter, milk, vegetables, and meat! Astra, write me a letter! Now goodbye! Kisses. Your Daddy.

Friedel.'

A few days later he fell ill. The morning when the nozzle burnt out he was in a bad way with a temperature of 39.4°C. His head split, and his side pained. Then a rash broke out, and he was sent to the isolation hospital with typhus. There is a note in his case history: 'All evidence is that the patient caught typhus on the way here.' He had wanted to leave more money at home and had travelled third class.

He lay unconscious in a ward for six patients.

In Nakhabino the nozzle was repaired, and the engine started again.

A bang and then even burning. The OR-2 worked for about twenty seconds. Then golden sparks flew from it. The commission from the Revolutionary Military Council established that the nozzle had burned out on the inside.

Zander knew nothing about it. That day he was taken to a separate ward. A nurse sat beside him, but he no longer saw either the room or the girl's face.

He died at six a.m. on 28 March 1933 and was buried in Kislovodsk.

The last letter he wrote to his friends at GIRD ended: 'Forward, comrades, and only forward! Raise the rockets higher and higher, closer to the stars.'

When the telegram arrived from Kislovodsk everybody was stupefied. Korolev wept and did not hide his tears. Then he asked quietly: 'What will happen to GIRD now?'

For some reason or other, people imagined Korolev to be incapable of weakness. But he was, and there were such moments. And that is fine.

Korolev spoke at the memorial meeting about how much Zander had done for rocketry and how his work had imperishable significance.

Such things are always said at memorial meetings, but Korolev's words were not just the usual tribute. F.A. Zander occupies a special place in the world constellation of pioneers of astronautics. The closest to him in age and aims was probably Robert Goddard. Theodore vom Karman (with Lee Edson) wrote in *The Wind and Beyond* that it is impossible to draw a direct line between Goddard and modern rocketry. He was on a branch that died out. Zander was on a branch that lived.

'Zander's work,' A.A. Blagonravov, Member of the Academy of Sciences, said in 1967, 'was such that research workers and designers have found it possible to draw new ideas from it. His legacy still helps us to look ahead and to utilize what he wrote and what he thought about for the further progress of rocketry.'

At the beginning of 1933, when GIRD's main attention was focused on testing Zander's engine, the other teams did not sit with folded hands. Zheleznikov produced the complete technical specification for the RP-2 plane. Pobedonostsev prepared the documentation for a jet projectile and was finishing building an experimental installation for testing ram jet engines. And then he carried out a series of bench tests of pulse-jet engines. In the spring Tikhonravov's group was actively testing incendiary propellant charges and various parts of the 09 rocket.

It was already clear to everyone that it was impossible to work any longer in the basement, that GIRD as it existed had grown beyond the framework of Osoaviakhim's 'group for studying reaction propulsion' and that it urgently needed reorganization. The question of setting up a rocket

centre was still undecided, despite Tukhachevsky's letters. Kaganovich suddenly remembered this letter in February 1933 and gave orders for the Moscow City Committee of the Communist Party and the OGPU to evict some civilian institute from Moscow within 20 days and hand over its building to Tukhachevsky. The Fur Institute was marked down for eviction, but no decision materialized. Several other buildings were considered, and all of them turned down. A new lull set in.

Tukhachevsky had not given up the idea of reorganizing GIRD as a military establishment. That would immediately alter the attitude toward the rocket people and improve their position as regards supplies.

In February the Chief of the Department of Military Inventions, G.P. Novikov, wrote to the Central Council of Osoaviakhim asking it to transfer GIRD to his Department. In March L.P. Malinovsky, the Vice-Chairman of the Central Council, replied that Eideman had agreed in principle to the transfer.

In April Novikov reported to Tukhachevsky:

> 'I deem it expedient and opportune to raise the question of the transfer of GIRD from Osoaviakhim to the War Department. In fact, GIRD at present has a dual subordination while doing its main work for the War Department, and in this respect, being responsible to the War Department, it is formally subordinated to the Central Council of Osoaviakhim.'

This point of view was also held by the Praesidium of Osoaviakhim. Of course, it was time to transfer GIRD over to the system of the Chief of Armaments, Red Army.

'In the interests of the work,' Eideman wrote to Tukhachevsky, 'it is certainly necessary, because GIRD's work has already gone beyond the limits envisaged by the Central Council when organizing it.'

Four days after writing this letter Eideman reported to

the People's Commissar for the Army and Navy, K.E. Voroshilov:

> 'At present work on studying the problem of reaction-propulsion engines has now attained such development that it cannot be carried on properly within Osoaviakhim's system and requires broader and deeper study.'

The day before that Korolev sent Tukhachevsky a letter that began: 'The difficult positions of the group for studying reaction-propulsion engines (GIRD) which I lead, and the absence of any foreseeable end of our trying experiences forces me to approach you directly.'

Korolev recalled the conference of 3 March 1932 at the Revolutionary Military Council and the decision to set up a rocket centre, and said that nothing had been done. And he enumerates the points that required urgent solution: premises, supplies, transport, finance, living conditions, and personnel*.

It is a remarkable coincidence, but it has long been noticed that it is hardest of all to take a decision that nobody opposes. In this case everyone was 'for', and no one was 'against'. GIRD wanted to be under the War Department. The War Department accepted, Osoaviakhim was agreed. But things did not move. The top authorities dawdled with the decision that they wanted so much in GIRD's basement, and the Department of Military Inventions and the Finance Department of the Red Army, in what seemed a gibe, sent auditors to GIRD.

The vigilant auditors found breaches of business and financial discipline, slips and omissions in book-keeping

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* Pluralizm and part-time work continued: Tikhonravov was on the staff of an aircraft factory, Chesalov and Shchetinkov of the Central Institute and Fedulov at the Moscow Aviation Institute, and so on.

and accounting, and noted at the same time that 'GIRD has set up a production base fully adequate for carrying out the work in hand', that 'the position with personnel is satisfactory', and that Korolev had unlawfully appropriated the sum of 1200 roubles. The auditors were quite categorical in their conclusions: 'The state of accounts and book-keeping is so unsatisfactory as to facilitate the perpetration of frauds of various kinds.'

An order was issued signed by the O.C. of the Department of Military Inventions: 'The head of GIRD, Com. Korolev, is reprimanded for the unsatisfactory state of GIRD's business and financial activity and warned that, if there is any repetition of such occurrences, stricter measures will be taken.' The auditors made life hard for Korolev for most of half-a-year. Only at the end of July did he send in a detailed report on the situation, explain everything in detail, point by point, write about the commission's tendenciousness and bias in not taking into account the difficulties of GIRD's work, explain where ill-starred 1200 roubles had gone and demand: 'I ask to be cleared of this shameful accusation.'

Zander's death, the failure of the OR-2, the dim prospects of GIRD's future, and finally this artificial and, as regards timing, highly inconvenient audit, which gave rise, in addition, to months of absurd correspondence, all made Korolev himself feel very dejected. But he pulled himself together, forcing himself not to weaken and to concentrate on the main thing. And the main thing was the work. He now firmly believed what he had told Zander, that no laboratory successes and no test-stand victories would ever convince anyone. A flying rocket plane, a vertically launched rocket, something real that would speak for itself was what he needed now most of all. By the summer of 1933 it became clear that the greatest progress could be expected from Tikhonravov's team.

The Central Council of Osoaviakhim asked Korolev to

send a qualified engineer to Baku to give a series of lectures on rocketry and interplanetary flight. He sent N. I. Efremov, a senior engineer from Tikhonravov's team. In Baku Efremov became acquainted by chance with an inventor Gurvich. In a conversation with him Efremov said:

'If only we could solidify petrol! After all, we have dry alcohol... .'

'And dry petrol,' Gurvich interrupted. 'It's not quite solid, but dry.'

Efremov brought a three-litre tin of a jelly-like mass back with him to Moscow, a present from Gurvich, wrapped in a shirt so that the car attendant wouldn't notice it. As a follow-up Gurvich sent him a whole barrel of solid petrol.

At the time Tikhonravov's group was working on a rocket identified in the papers by the index number 07. Four long fins branched off its short body. The fins contained the fuel and oxidizer tanks: the 07 worked on kerosene and liquid oxygen. The engine was being stand tested; it had burnt out several times. They had worked on it for a long time, and the end was nowhere in sight. The solid petrol from Baku, which was actually ordinary petrol dissolved in rosin, gave Tikhonravov the idea for a new rocket, which received the designation 09.

Its design was simplified by the fact that no pumps and no system to feed the fuel to the combustion chamber were required. The liquid oxygen boiled in the tank and was forced into the chamber by the pressure of its own vapour. The solid petrol was placed directly in the combustion chamber and ignited by an ordinary aviation sparking plug. Fully tanked, the rocket weighed 19 kilograms.

Stand tests of the separate units of the 'Nine' had already begun in March and April at Nakhabino. Korolev followed them with attention, and was present himself at many experiments. The solid petrol burned steadily and stably. The strength tests of the combustion chamber,

too, passed off well. Korolev saw that he could hope for success with the 'Nine'. But at the beginning of June they hit a patch of failures: petrol was ejected from the tank, the chamber burned out, valves seized up, and it was impossible to build up the necessary pressure in the oxygen tank. They machined, and soldered, and patched, and did the same job over again and again, and went back to Nakhabino.

Every test took an awful time and effort. It was necessary to make prior arrangements with Osoaviakhim or with the commander of the Spassky Barracks for the use of a one and a half-ton lorry; GIRD still had no vehicle of its own. The lorry was loaded with Dewar flasks, special vessels Zander had constructed for storing liquid oxygen. They were quite awkward copper vessels with double walls (gap filled with liquid carbon dioxide) and blanketed with glass wool. As the vessels were filled with liquid oxygen the carbon dioxide froze and sank in the form of flakes to the bottom, forming a vacuum between the walls that was an excellent thermal insulator. But in spite of all these contrivances the oxygen did not keep well in them, and they had to be filled up at the Compressed Gas Works and driven at full speed to Nakhabino before everything boiled dry.

Occasionally, but very seldom, there was even some oxygen left over after the tests; then all sorts of unusual experiments were devised. At the time liquid oxygen was a very exotic liquid, few people had worked with it, its properties were not clearly known, and people were therefore afraid of it. It was believed that there would very likely be an explosion if oil got into it. As a joke, the girls, the draughtsmen, were forbidden to bring even buttered sandwiches to the basement.

'Let's see how it explodes,' Korolev once proposed.

What was left of the oxygen was poured into a roasting pan.

'How beautiful it is!' cried Zina Kruglova, a designer, watching the light blue, vigorously boiling liquid. 'Just look, its colour's electric.'

'That's the colour of our atmosphere,' Korolev said. 'Now give me some grease and move further away.'

Only Korolev and Tikhonravov remained near the steaming pan. To everyone's astonishment the oxygen behaved quite peacefully with the grease. No explosion followed.

Then they grew bolder. Daisies were thrown into the liquid oxygen, and they instantly froze to stone. One of the mechanics froze a frog. The icy frog slipped out of his hand and broke to pieces with a light glassy tinkle.

The amusements took their course, but the mood was morbid. It was a rare experiment with the 'Nine's' engine that went well. Most often the chamber or the nozzle burned out. Only at the beginning of July did they at last succeed in taming it. Korolev insisted on preparing to launch the rocket as soon as possible, and hurried up the testing of the parachute that was to return it to the ground.

These tests were not made in Nakhabino, but on the Tushino Aerodrome. The nose-cone of the rocket, containing the folded parachute and a solid-fuel ejector, was fixed onto a wooden model. An Osoaviakhim pilot Kravets and Efremov were to drop the model with an ignited Bickford fuse from a U-2 plane flying at one thousand metres. Kravets was worried; he didn't like the idea of the ejector going off inside the plane—he had no faith in these inventors. Efremov's matches blew out; the fuse refused to burn at first, but finally began hissing, throwing off sparks, and the rocket was sent hurtling down. Kravets sighed with relief. He had worried without cause; the ejector didn't work and the parachute did not open.

The failure at Tushino seemed to begin a new patch of failures. The chambers and the nozzles began to burn out again, and the injectors were blown out. The workshop was now working almost exclusively on the needs of the

'Nine'. Tikhonravov, harrassed and utterly exhausted, was at last persuaded to go on holiday, and he and Zuev and Andreev were sailing and fishing somewhere on the river Khoper. As soon as a new chamber and a new nozzle had been made Korolev ordered a launching.

On August 11th the C.O. of Inventions Department, Ya. M. Terentiev, Korolev, Pobedonostsev, Korneev, and Efremov went to Nakhabino. There were many people, thirty or so persons present. The rocket was mounted on the launching rig. Zina Kruglova with her sleeves rolled up filled the chamber with solid petrol. Efremov poured in the liquid oxygen; and instantly everyone saw that the oxygen valve was leaking. The leak was stopped. Oxygen tank was filled. Everything now seemed to be in order. The pressure in the oxygen tank rose normally. Efremov reported to Korolev that everything was ready and asked permission to fire.

Everything looked very solemn. Korolev ignited the Bickford fuse of the parachute ejector.

'Ignition!' he cried at last.

There was silence, with only the hiss of the fuse.

'What's the matter there?!' Korolev turned toward Efremov. In reply there was a loud bang from the ejector and a perfectly useless parachute shot out. The rocket did not take off; the sparking plug in the chamber had shorted.

On the day of the next test, August 13th, the weather was horrible, cold and rainy. The result was the same, even the worst yet; the chamber burnt out again, the casing caught fire, and they had trouble putting it out. Korolev went round as black as a cloud. In the basement they spoke openly of the failure of the 'Nine' project. No one any longer believed in success, and no one wanted to go to the testing ground. The new tests that Korolev ordered for August 17th aroused no enthusiasm.

'Won't something go wrong again? What will it be this time?' asked Olga Parovina.

P. Ya. Korolev.

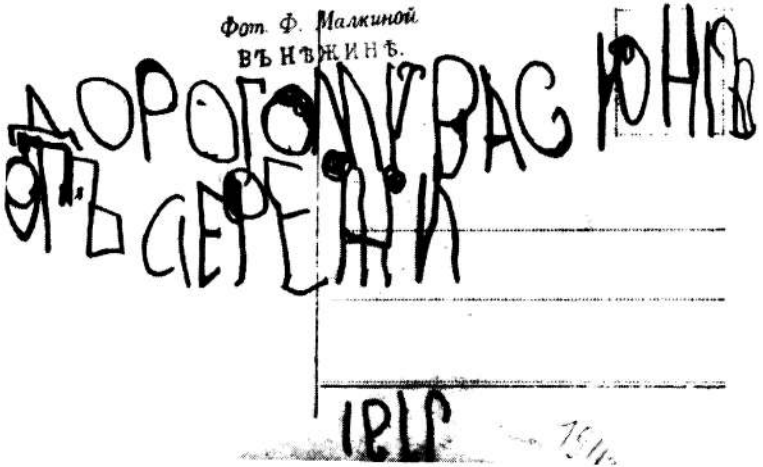
M. N. Koroleva.

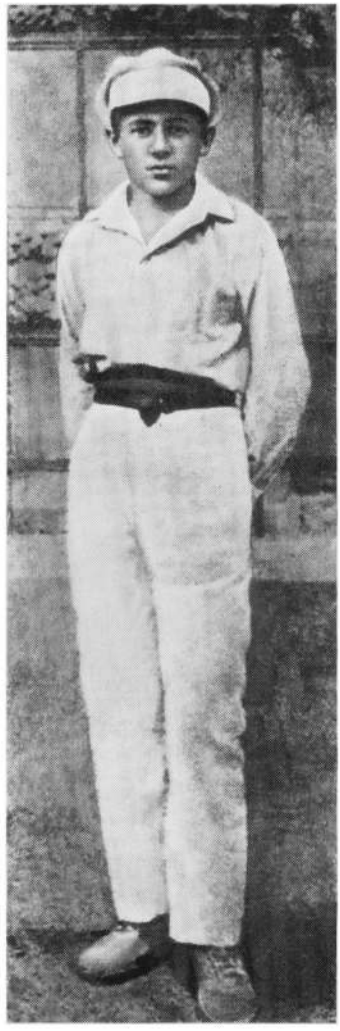
The Moskalenko family in Nezhin in 1909. Left to right: daughter Anna, Nikolai Moskalenko, son Vasily, grandson Sergei Korolev, Maria Moskalenko, son Yuri, daughter Maria (Koroleva).

Sergei Korolev
in 1909.

The house in Zhitomir where Sergei Korolev was born.

The first autograph of the future member of the USSR Academy of Sciences.

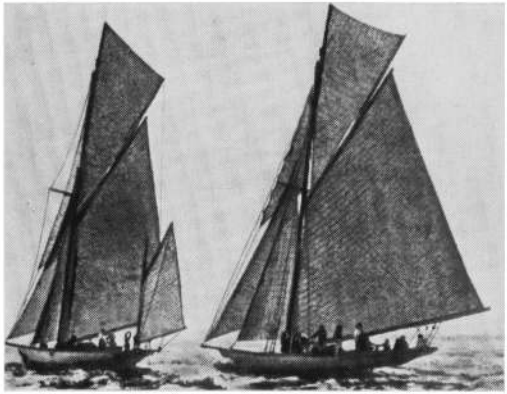




Sergei Korolev in Odessa.

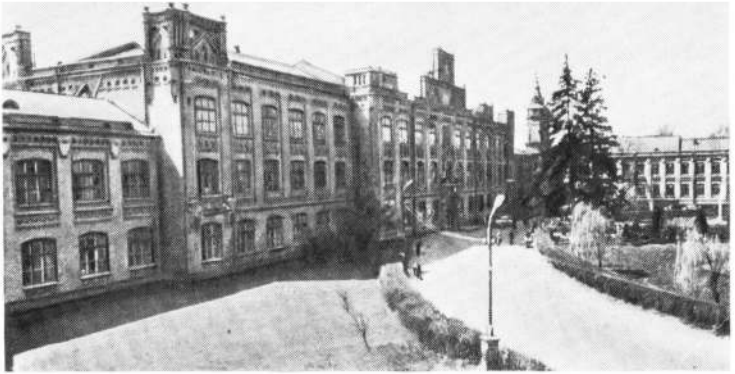
G. M. Balanin.

Odessa Harbour in the Twenties.



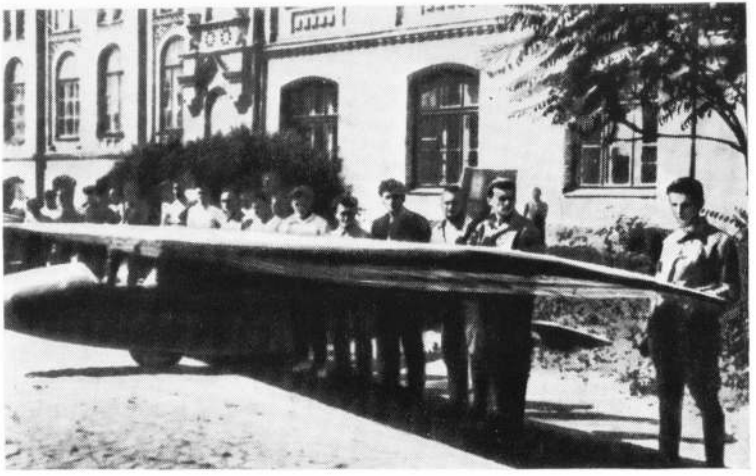
The yachts *Mirage* and *Mayana*.

The building of the Odessa Building Vocational School where Sergei Korolev studied.



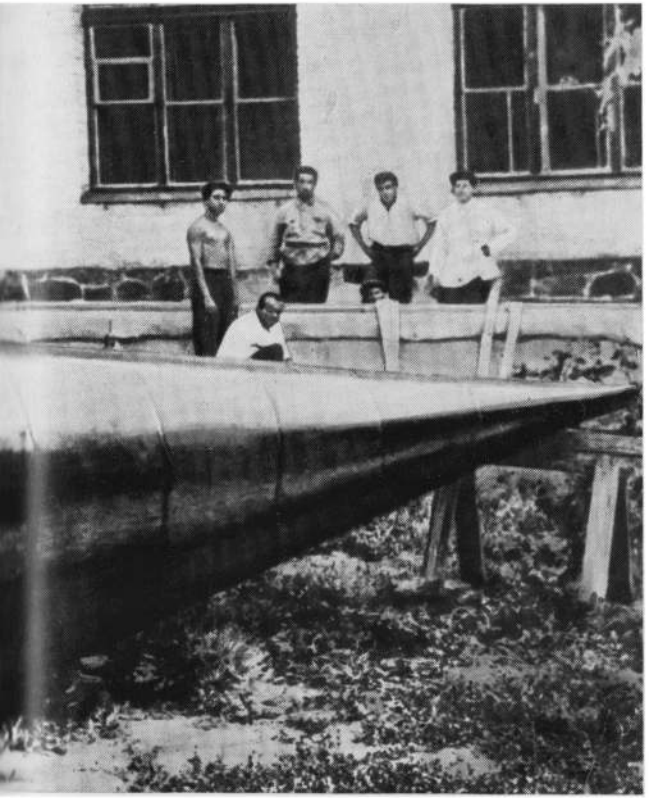
Kiev Polytechnical Institute.

Parade of gliders in the grounds of Kiev Poly. Sergei Korolev is sixth from the right.



S. P. Korolev as a student at Kiev Polytechnical Institute.

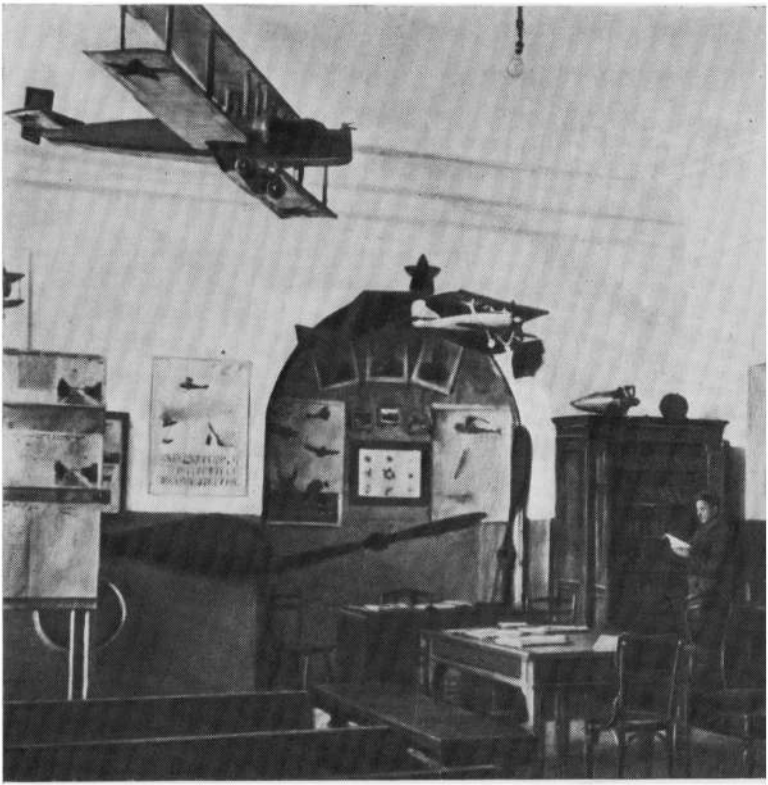
The KPIR-4 glider, which Sergei Korolev helped to build. Left to right: Konstantin Yakovchuk, Nikolai Zheleznikov, Vladimir Savinsky, Stepan Karatsuba, Dmitry Tomashevich. Second from the right in the group in the background is Sergei Korolev.



Pilot
A. B. Yumashev
with his
Yu-1 glider.

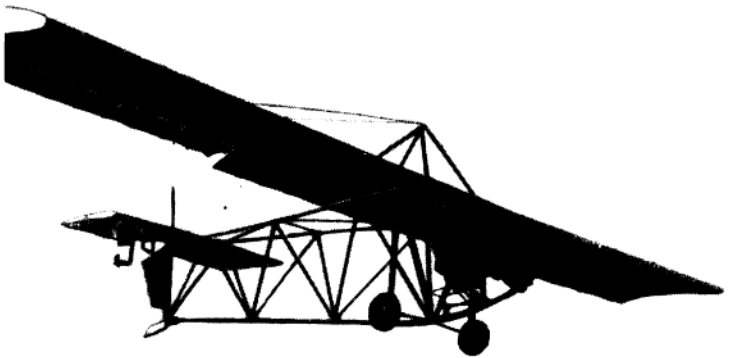
The 3rd Glider Rally at Koktebel. Left to right: K. K. Artseulov, K. N. Yakovchuk, V. M. Zernov.

V. V. Sineutsky (left) and N. B. Delone advising K. N. Yakovchuk, leader of the Kiev Poly glider circle.

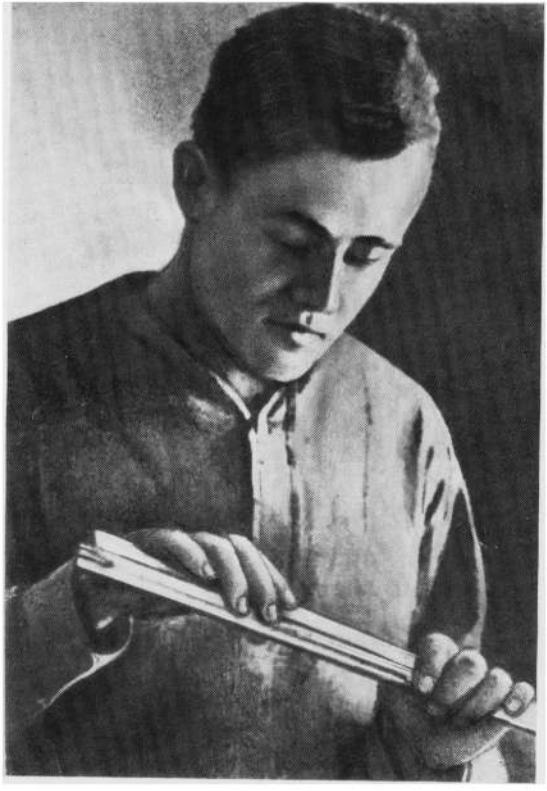


The aviation room and library of the Aviation Scientific and Technical Society.

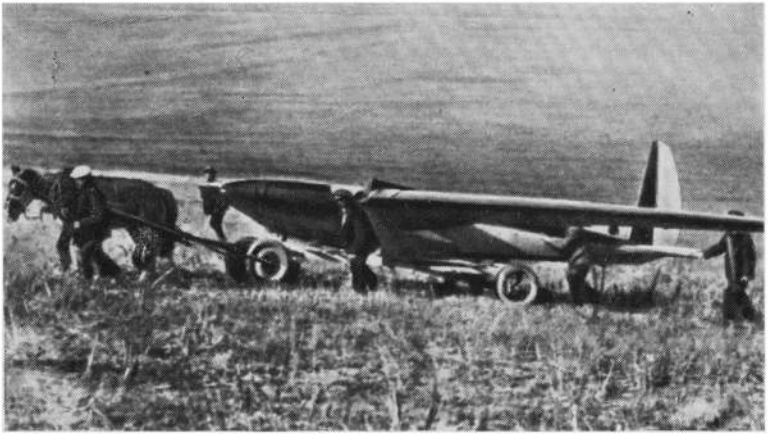
Building gliders at Kiev Poly.



The KPIR-3 glider, constructed by S. I. Karatsuba and E. F. Ambold, in flight. Sergei Korolev glided in it in 1925.

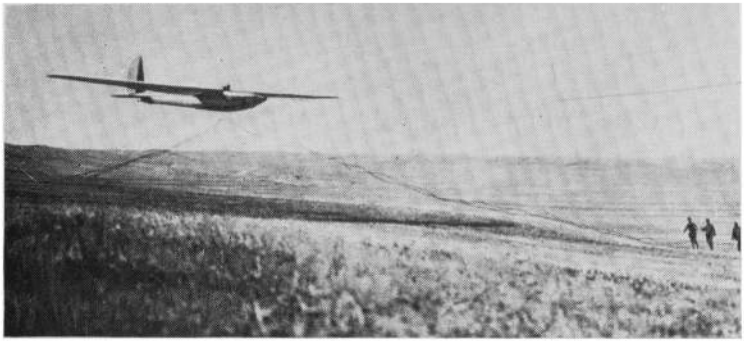


S. P. Korolev as a student at the Moscow Higher Technical School.



The 6th All-Union Glider Rally at Koktebel. Taking the Koktebel glider, constructed by S. N. Lyushin and S. P. Korolev, up to the starting point.

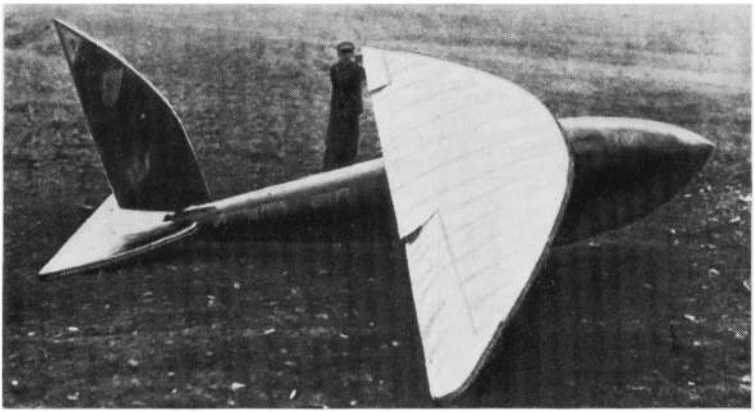
Koktebel, 1929. The Koktebel glider in flight.



Left to right: S. P. Korolev, S. N. Lyushin and K. K. Artseulov beside the Koktebel glider.

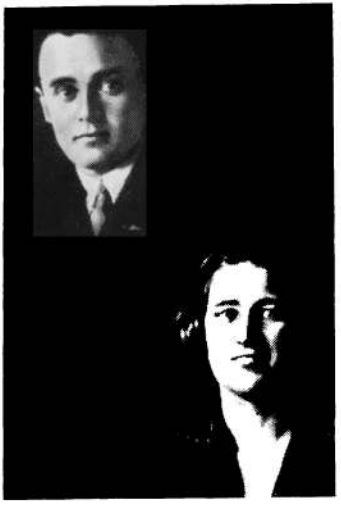
The 4th All-Union Glider Rally at Koktebel. This photograph used to hang in the study in S. P. Korolev's home.

S. P. Korolev in 1929.



The Gnome glider constructed by B. I. Cheranovsky.

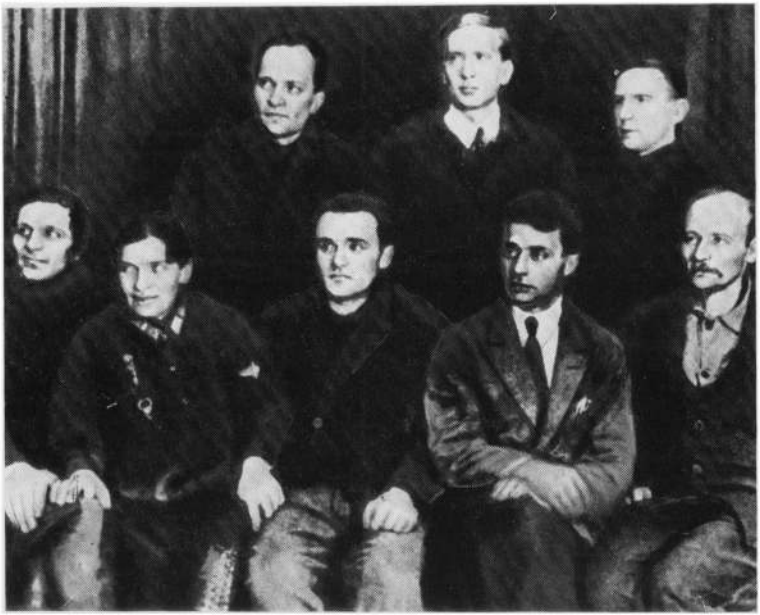
A group of glider pilots at the 4th All-Union Glider Rally. Third from the left is S. P. Korolev.



S. P. Korolev
and N. M. Vincentini.

S. P. Korolev and D. A. Koshits beside the wrecked SK-4 light plane.

S. P. Korolev
and X. M. Vincentini
in Sevastopol in 1932.



The founding group of Moscow GIRD: front row centre S. P. Korolev; extreme right F. A. Zander; back row centre – Yu. A. Pobedonostsev.

Poster advertising a debate on 'Flight to Other Worlds' in the Large Hall of the Physics Institute of the First University, on Herzen St. F. A. Zander is billed to speak on the spaceship devised by him to resolve the problems of flight in outer space.

ДИСПУТ

ПОЛНОЕ ПОВТОРЕНИЕ

Суббота 4 Октября

БОЛЬШАЯ АУДИТОРИЯ ФИЗИЧЕСКОГО ИНСТИТУТА ПЕРВОГО УНИВЕРСИТЕТА

Улица Герцена, 6 (б. Большая Никитская)

ПОЛЕТ НА ДРУГИЕ МИРЫ

Правда о полете снаряда проф. Годдарда на луну 4 окт. 1924 г. в Америке

СПОРЫ НА ЗАПАДЕ В СВЯЗИ С ОТПРАВЛЕНИЕМ СНАРЯДА НА ЛУНУ.

Проф. из Ленинграда, член Совета О-ва Мироведения

В. В. ШАРОНОВ.

Переполох в Зап. Европе и Америке в отношении к проблеме межпланетных сообщений в наши дни

Величайшая загадка вселенной. Интересное предположение американского ученого Гаррета Сервиса

Самая мощная машина в мире. Чудесные возможности снаряда с ракетной артиллерией в Америке в 1920 г

Электромагнитные пушки сверхдальней стрельбы. О реальной возможности полета человека в ядре этих пушек

Картины жизни на небесном корабле. Сказочная действительность. Невиданные небесные панорамы.

Проблема межпланетного полета и судьба жизни на земле. Путь к разрешению тайн мироздания

Цены билетов от 30 к.

Сообщение члена Президиума Московского Общества изучения межпланетных сообщений инж. Ф. А. ЦАНДЕР

О ИЗОБРЕТЕННОМ ИМ НОВОМ КОРАБЛЕ, РАЗРЕШАЮЩЕМ ЗАДАЧУ ПОЛЕТА В МИРОВОЕ ПРОСТРАНСТВО.

Каким образом устраняется газовое и единственное препятствие к немедленному осуществлению полета на другую планету

Преимущества небесного корабля Цандера над снарядами Оберта в Германии и Годдарда в Америке

Ближайшее будущее.

ДОКЛАДЫ беспрерывно иллюстрируются световыми картинами.

ПОСЛЕ ДОКЛАДОВ ПРЕНИЯ—

действительно ли разрешает изобретенный инж. Цандером небесный корабль задачу полета в мировое пространство

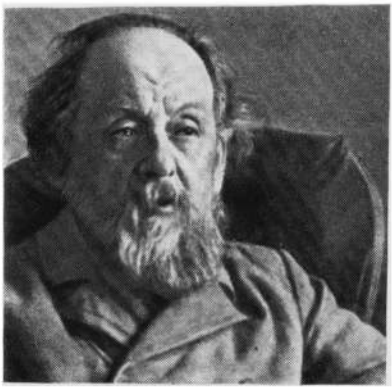
При участии ... профессоров и инженеров

Начало в 8 час. вечера.

S. P. Korolev as head of Moscow GIRD.

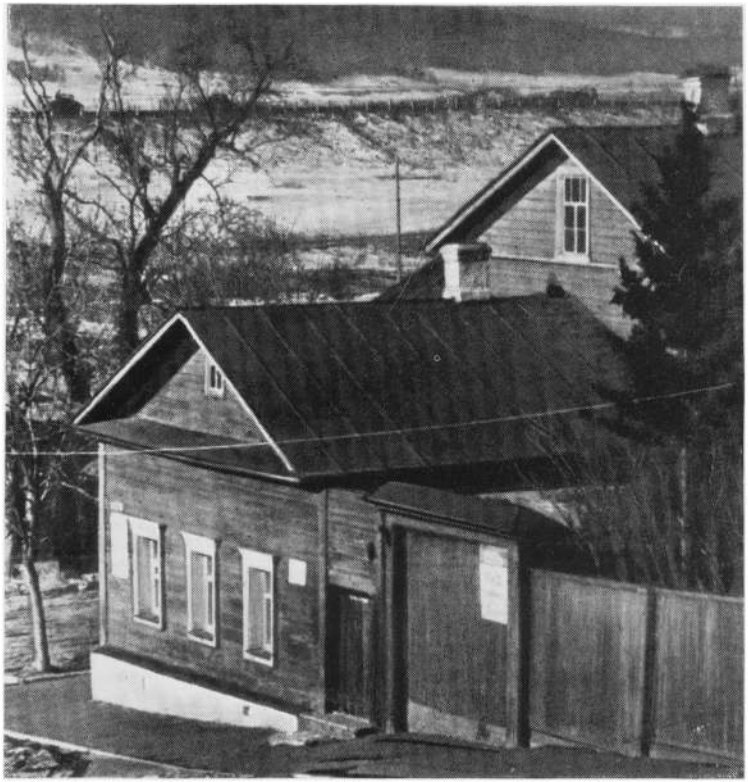
F. A. Zander in 1913.

F. A. Zander at GIRD in 1933.

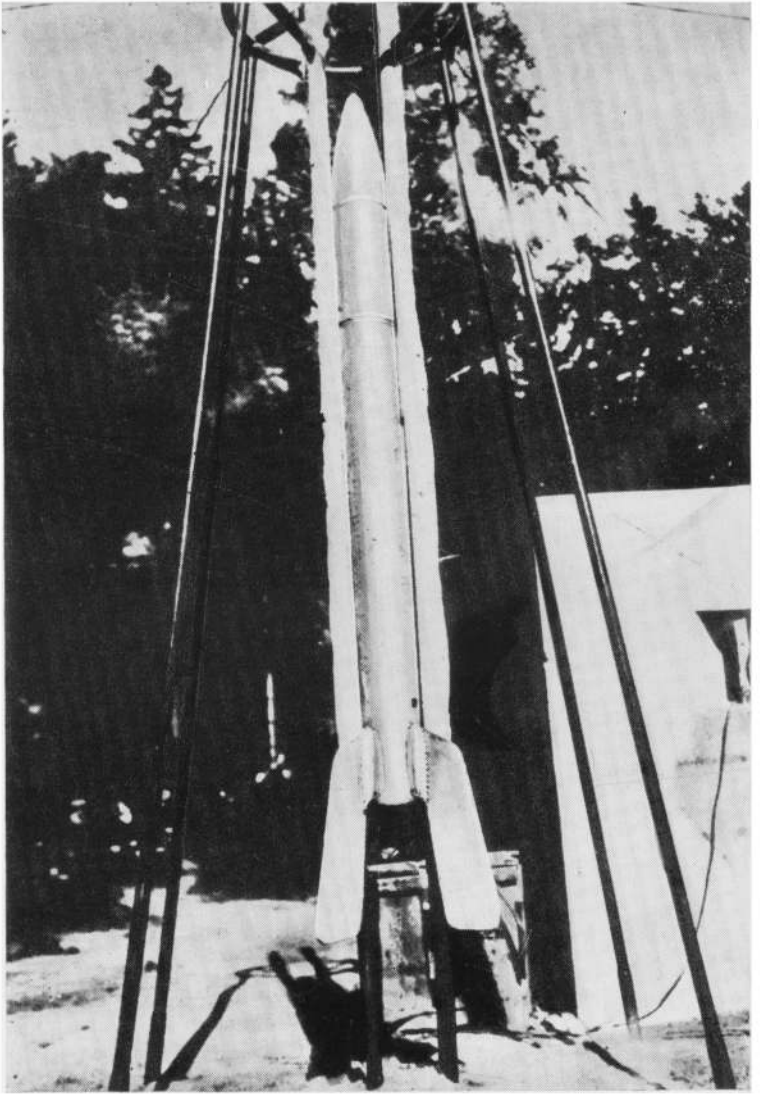


K. E. Tsiolkovsky.

F. A. Zander's grave
in Kislovodsk.



K. E. Tsiolkovsky's home in Kaluga.



A group from GIRD with the GIRD-X rocket, November 1933. S. P. Korolev is on the extreme left.

The 09 rocket on the launching stand at the Nakhabino proving ground, August 1933.

Memorial at the spot where the first Soviet liquid-propellant rockets (09 and GIRD-X) were launched in 1933. Erected by the Young Communists of Nakhabino Secondary School No. 2. The stone bears the names of S. P. Korolev, F. A. Zander, and M. K. Tikhonravov.

That annoyed Efremov. 'Drop that faint-heartedness. Everything will be normal. The rocket is bound to fly. I'll stake my head on it.'

Thirty-four years later, Nikolai Efremov wrote about these pre-launch minutes:

> 'The rocket was already fuelled and mounted on the launching rig. Korolev and I were standing beside it watching the build-up of pressure in the oxygen tank. The gauge was small and at the top of the rocket. The finer divisions were not very distinct and we had to stand on tip-toe to see the pointer move.
>
> 'The pressure reached 13.5 atmospheres. And then the reduction valve began to leak. Another low-temperature "joke". A piece of ice had frozen somewhere on the flange of the valve and now it didn't fit properly in its seating. As a result, as much oxygen was leaking out into the atmosphere as was vaporizing in the tank. Equilibrium had been established. It is clear that the pressure would not go higher.
>
> 'Korolev and I had a quick consultation. I suggested launching with reduced pressure. We might not reach the estimated altitude, but we'd have a flight and get answers to the questions that interested us. The Chief did not hurry to reply, pondering the situation, but finally gave his consent.
>
> 'Everything else went properly. The Bickford fuse of the parachute-ejector system was lit and we scuttled off to the shelter to direct the launching from there.'

What happened then is told in minute No. 43 on the tests of rocket 09 for 17 August 1933:

> 'Gave ignition with simultaneous opening of the valve, normal combustion began, and the rocket slowly rose from the rig.

'Gradually gaining speed the rocket reached an altitude of 400 to 500 metres where, after lurching once or twice, it hulled over and went in a smooth curve toward a nearby forest and hit the ground.

'The whole flight lasted 13 seconds from the moment of ignition to hitting the ground; and all that time combustion took place (the motor worked).'

The impact broke the rocket in two, tore off a fin, and dented the skin, but no one took any notice. Everyone was shouting and laughing, and hugging, and kissing one another. Pobedonostsev, who had climbed up a fir-tree with Matysik at the launch, lost a puttee in his joy. Efremov sent a telegram to Tikhonravov in Novokhopersk: 'Examination passed. Nikolai'. Korolev squatted near the rocket, still hot and smelling of petrol fumes and scale.

'The fin and the dents are from hitting the trees,' he quietly explained to himself. 'So, it's clear. It lost stability because of the gasket on the flange. The gasket was blown out, the gases went out through the gap and turned the rocket. Everything's clear.'

A special issue of the GIRD wall-newspaper, 'The Rocket', was put up. Under the slogan 'Soviet Rockets Will Conquer Space!' was a photograph of the broken rocket and around it all the ten participants of this historic event. Korolev wrote in that issue:

'The first Soviet liquid-propellant rocket has been launched. The day of August 17th will undoubtedly be a memorable day in the life of GIRD, and from this moment Soviet rockets should start flying above the Union of Republics.

'We at GIRD must exert all our efforts to reach the estimated performance of the rocket this year and to hand it over for service in the Workers' and Peasants' Red Army.

'In particular, special attention must be paid to

the quality of work at the proving ground, where, as a rule, there are always many discrepancies, finishing touches, and so on.

'It is also necessary to complete and send up other types of rockets as soon as possible in order to make an all-round study and attain adequate mastery of rocketry.

'Soviet rockets must conquer space!'

Well in the autumn, when snow had already fallen, the GIRD-X, an idea of Zander's built by his associates in the first team, was launched. Those two rockets were really historic; they mark the beginning of the record of Soviet liquid-propellant rockets.

HAPTER 19

GIRD's victories were not just technical ones. The successful launches at Nakhabino did much to change the general attitude toward rocketry. They confirmed the convictions of those who had faith in the rocket and made those who did not believe in them waver in their scepticism. The outlook became clearer: 'From experimental rockets and cargo rockets to rocket ships and rocket planes—that is our path,' as Korolev expressed it in *Vechernyaya Moskva*, the Moscow evening newspaper, on 25 August 1933. These launches undoubtedly also helped with organizational matters. The delays in the setting-up of a unified research centre that annoyed Korolev so much could sometimes be explained as a sincere desire to get to the bottom of the matter and find the best solution. Take, for example, the work of the Military Inspectorate under N.V. Kuibyshev, brother of V.V. Kuibyshev, Lenin's successor as head of the Soviet Government. The Inspectorate was asked to inspect organizations working in the field of rocketry. In a memorandum to K.E. Voro-

shilov dated June 1933 it was noted that the work of the GDL and GIRD was of 'first-rate importance' and at the same time frankly recognized that 'up to the present GIRD has not had suitable premises, transport, personnel, equipment and materials, the necessary funds, or a proving ground for tests'.

The Inspectorate's conclusions once more confirmed the view that 'the further existence of the GDL and GIRD as independent organizations is unadvisable in view of the frittering of funds and of the meagre cadre of research workers in reaction propulsion, and also in view of the absence of a clear line of division in the work and of parallelism'.

The memorandum proposed unifying the GDL and GIRD and 'to withdraw the newly created institute from the jurisdiction of the Department of Military Inventions and to put it, with the aim of improving its connections with industry and providing it with a production base, under the People's Commissariat of Heavy Industry'. Voroshilov agreed in a resolution to Tukhachevsky that '... it would be best to transfer this affair to the PCHI'.

In September 1932 an order of the Revolutionary Military Council of the USSR was promulgated on the founding of a Reaction Propulsion Research Institute on the basis of the GDL and GIRD. And on 31 October 1933 the Council of Labour and Defence at last adopted a resolution confirming the Military Council's 'Order on the Organization of the Reaction Propulsion Institute', the first state establishment in the world, incidentally, working on problems of rocketry. A top-ranking military engineer from Leningrad, I.T. Kleimenov, was named head of the Institute with Korolev as his deputy. On 15 November 1933 the Institute was transferred to the People's Commissariat of Heavy Industry.

The premises of the new Institute on the outskirts of Moscow seemed a veritable mansion; a two-storey house and an adjoining production block were the beginning of

the Institute. The production block had previously belonged to a Diesel engine laboratory and some of engine-beds remained. Then it had housed builders of some sort, and there was dirt everywhere, rack and ruin, and bedbugs in the cracks. Korolev realized that the long-awaited solution meant a future of enormous administrative and organizational cares and meant being out off from the main job.

But the peeling walls and frozen deserted rooms could not damp the joy of the GIRD people. For them they were not simply new premises and a new sign-board. Yesterday's dreamers and enthusiasts who began as an amateur group, and who still, despite the interest taken in them by the Department of Military Inventions, remained a part of Osoaviakhim, a voluntary organization, were being transferred to industry. They had become respectable, acknowledged, trusted, they grew up rapidly from passionate youths to men wise with experience.

A club room on the Kolkhoznaya Square was rented for an evening party in honour of the birth of the new Institute. Korolev made his appearance at this party wearing, for the first time, two pips on tabs of his tunic: as deputy head of the new Institute he was given the rank of divisional engineer. It cannot be said that Korolev was indifferent to titles and decorations in his young years, or later for that matter. On the contrary, he could even be called vain; but it was not the puffed-up vanity of a mediocrity who imagines that a title or rank is tantamount to intellect and talent. Korolev needed all the regalia primarily to further his cause, and through it—himself, for he identified his ego with his cause. His vanity was born out of the need constantly to convince people of the importance of his work. The pips were acknowledgement of GIRD's sleepless nights, the rank of divisional engineer today meant that it would be easier for him to carry out his designs tomorrow. And then divisional engineer was the equivalent

of lieutenant-general of engineers, and this lieutenant-general was twenty-six years of age. At that age it would be horribly hard not to be proud of such a rank.

Badges and gifts were bestowed during the party. Korolev received Osoaviakhim's highest decoration—the badge 'For excellent work', Gorbunov and Pivovarov the Osoaviakhim's badges for distinguished work, Shchetinkov and Avdonin, watches engraved with commendations, and Ivanova, a case of drawing instruments with her name engraved on it. The loudest expressions of joy, however, came from Sergei Smirnov; his gift was a fur-lined leather coat and a woollen scarf, something not to be compared with a case of instruments!

Then there was dancing and singing; the party went on late into the night. Korolev, at once proud and shy of his pips, made a short, vigorous speech summing up the results of work in the basement. The evening marked the end of the wonderful story of GIRD, a short, difficult, and happy story that Korolev could never forget, because GIRD was his youth, because GIRD was the beginning of the Main Thing.

It took time to wind up the activities of the Leningrad group in the Peter and Paul Fortress, to dismantle the test beds, to pack the equipment, to find accommodation for its staff in Moscow, and to arrange the host of petty matters involved in moving a whole establishment from one city to another. Kleimenov came down from Leningrad, interrogated Korolev closely about everything and went back again. In the first months of its existence the Rocket Institute was no different from GIRD. (Korolev signed the minute on the testing of Tikhonravov's No. 43 rocket on 17 August 1933 as 'Head of GIRD'; after October 14th his signature read 'Deputy Head, RI'.) Work went on as before, but rather sporadic.

Every day Zina Kozhemyakina, the driver, drove her battered lorry loaded with desks, chairs, sundry useful bits of metal, and other treasures that had been heaped up in the basement over the two years; they loaded and unloaded, and made themselves comfortable. They finally left the basement toward spring when the people from Leningrad arrived.

In the spring of 1934 another event occurred that helped Korolev take another look back and sum up his first results in the field of rocketry for himself and to define the ways for further progress. On March 31th an All-Union conference on study of the stratosphere opened in Leningrad.

This conference was preceded by the first stratospheric flight in the USSR undertaken by three balloonists: George Prokofiev, Ernst Birnbaum and Konstantin Godunov in the stratospheric balloon 'USSR' on 30 September 1933. A month later a scientific meeting to consider the results of the flight had been held in the large conference hall of the Academy of Sciences, after which a ginger group, consisting of S.I. Vavilov, future President of the Academy of Sciences, the Academy members I. V. Grebenshchikov, N.N. Pavlovsky, and D.S. Rozhdestvensky, and Professors L.V. Mysovsky and A.B. Veringo and others, delivered a memorandum to the Praesidium of the Academy urging the convening of a conference. The Praesidium accepted the idea, and an organizing committee with Vavilov as chairman was appointed, and a programme laid down. It was found that the stratosphere interested scientists of quite varied specialities. Papers and abstracts on aerology, acoustics, optics, atmospheric electricity, geomagnetism, the aurora borealis, cosmic rays, and biological and medical problems were submitted. Rockets occupied a rather modest place in the programme, but right in his open-

ing address, which followed a minute's silence in tribute to the crew of the stratospheric balloon 'Osoaviakhim-1' killed in a fatal crash, Vavilov said:

'The conference should take a decision on the most rational designs for stratospheric balloons, on the prospects for stratospheric flight and on rocket flights.'

The word 'space' was probably not pronounced at the conference, but today, looking through the long-forgotten forty-year-old reports (in our time scientific reports often grow old faster than their authors), one is able to discern in this conference the rudiments of modern space assemblies. The stratosphere—the threshold of space—then seemed to be a strong fortress; the plans for its siege and assault were discussed in Leningrad.

The chairman of the engineering section, P.S. Dubensky, who spoke immediately after Vavilov, noted the importance of rockets for study of the stratosphere.

'Modern planes,' he said, 'are still very imperfect devices from the point of view of their utilization of aerodynamic principles in flight... . The use of rockets offers very great prospects... . It seems to me that there are no technical obstacles to the building of a rocket capable of carrying instruments to higher strata than a sounding balloon. For many years, however, conquest of the stratosphere has been closely linked—and quite rightly so—with study of reactive apparatus. In this field it is necessary to develop work on a wide front.'

S.P. Korolev was very glad to hear such a refrain. It had been immediately posed in principle: which road to the stratosphere should be chosen? And no matter how much the present advantages of aircraft, sounding balloons, and stratospheric balloons were extolled, they all bore the deadly word 'ceiling' like a brand. This was not some technical obstacle, a ceiling not yet overcome by engineers, but a theoretical ceiling that could not be exceeded however much one tried. The rocket had no such ceiling. On

the contrary, the higher it rose, the less was the difference between its environment and a vacuum, and the greater was the efficiency of its motor. The victory of the rocket in the stratosphere was pre-determined by its very nature.

Korolev received the reports extolling sounding balloons and various ground methods of studying the stratosphere coolly, without being roused. They did not annoy him, as they used to. He did not regard stratospheric balloons as his possible rivals; they were rather his allies, working for him and providing him with specific, albeit approximate, sporadic data on the nature of the lower boundary of the stratosphere, which would help him build a stratospheric aeroplane and fly it at an altitude that no one had yet attained. He tried to look at every report through his rocket prism, and to extract something useful for his present and future work from every communication.

And there was very much that was useful. Prof. M.A. Bonch-Bruevich spoke of the use of electro-magnetic waves to study the atmosphere, N.I. Leushin spoke about the origin of radio-noise (that would be important in organizing communications with a stratoplane). This was followed by a report on the external and internal magnetic fields of the Earth (what would their effect be on the plane's navigational equipment?). Much was said about cosmic rays, which were the subject of a paper from the famous A.F. Joffe (their effect would probably have to be taken into account in the design) and from the young physicists Dmitry Skobeltsyn and Sergei Vernov. Korolev could not then know that many years later their roads would cross and that the instruments carried by his first interplanetary stations would bring credit for the discovery of the radiation belts around our planet to S.N. Vernov, Member of the Academy of Sciences. The well-known geneticist N.K. Koltsov also spoke about cosmic rays, stressing their biological effects. G.M. Frank talked about the danger of this environment to life, and L. A. Orbeli presented

a detailed and well-argued 'Plan of Research on the Effect of Stratospheric Conditions on the Organisms of Man and Animals'. Even the requirements that the space-suit of the future cosmonaut would have to satisfy were discussed in this paper. When Korolev was shown space-suits in 1961 and he saw the blue-green visors of the light filters, he suddenly remembered that then, a little less than thirty years before, in Leningrad, there had already been talk about light filters, the tasks of the optics had been pored and recommendations from eye-specialists demanded; and people were already thinking then of how man was going to watch the sky, the stars, and his native planet out in the abyss of space.

Orbeli was not exactly optimistic in his report; it was even a bit gloomy. 'It is impossible to complete the programme of purely physiological scientific studies that must be carried out in a very short time because of the rapid development of stratospheric work. There is no physiological problem that will not be relevant here.'

Korolev listened most attentively to A.A. Likhachev's paper on the effect of rapid acceleration on the human organism. The acceleration of the launches like those at Nakhabino, still fresh in his memory, would undoubtedly involve overloads that, according to the speaker, would 'no doubt be able to exert a considerable, and in some cases fatal, effect on the human organism'. Likhachev was one of those at the 1st Leningrad Medical Institute who had been won over by the ideas of that ardent apostle of astronautics, Prof. N.A. Rynin. In 1930 Rynin and his young medical friends built two centrifuges at the research institute of the Railway Institute. The first, a small one with a radius of 32 centimetres, turned at 2800 r.p.m. Insects and frogs were tested in it. The second, rather larger, with a radius of one metre, turned at 300 r.p.m.; it was used for experiments with mice, rats, rabbits, cats, and even birds: siskins, pigeons, and a crow. Interesting

data on the effect of the size and duration of the stress were obtained.

In Likhachev's report we come upon brilliant examples of scientific foresight: 'It will be quite advisable to use centrifuges to study the effects of the loads at different accelerations.' Years later special centrifuges for training astronauts and testing the instruments and equipment of spaceships were built.

'To study the effect of pitching and rolling it will be desirable to devise apparatus simulating it.' Special rock platforms and shakers were designed at the training centre for astronauts.

'To study the effect of additional factors (position of the body, temperature, humidity, gas composition, atmospheric pressure, etc.) it will be desirable to build a cabin with the appropriate equipment.' This was an order for an altitude chamber and an anechoic altitude chamber that was fulfilled quarter of a century later.

'It is desirable to study loads up to 10 g in experiments with human beings.' The first Soviet cosmonauts experienced loads in training of about that value.

Korolev was always extremely interested in what was to become known as the life-support problems of spaceships. This interest was a tradition; it came from Tsiolkovsky, who began by spinning cockroaches on a home-made centrifuge and ended up with the bases of modern space medicine and life-support systems, and from Zander with his naive and touching experiments on the arrangement of biological cycles on a Martian ship. We Russians began animating and humanizing rocketry from the moment of its birth. Korolev became so interested in the biological problems that he infected his wife with his enthusiasm, Lyalya being a doctor.

While Korolev was still working at GIRD a series of experiments in air regeneration and gas exchange was carried out at the Zhukovsky Air Force Engineering Academy,

partly on his initiative. A report on the work was published by the head of the Laboratory, N. M. Dobrotvorsky and Dr. X. M. Vincentini. To regenerate the air in the cabin of a stratospheric aircraft it proposed providing special cartridges and forced ventilation, and an oxygen reserve that could be drawn up in case the emergency valve released excess carbon dioxide not absorbed by the cartridges. Provision was also made for heating and drying the cabin. The sealed cabin was to be released and brought down by parachute; that is to say, in the way most Soviet space vehicles are returned to Earth. Even the clothing of the stratonaut had then been thought out: silk underwear and a wollen suit topped with a water-proof overall. The life of the pilot was to be preserved in the event of depressurization by a helmet of the type worn by divers, and an electrically-heated suit of air-tight fabric.

But let us return to the University Embankment in Leningrad, to the conference hall of the Academy of Sciences. Prof. N.A. Rynin is at the rostrum, making an exhaustive report on all the possible ways of conquering the stratosphere, citing a host of examples, and analysing the whole of foreign experience.

'Further progress in the altitude and speed of aircraft in the stratosphere is possible,' he concluded, 'but it entails using a reaction-propulsion engine.'

Nearly half of Rynin's paper dealt with rockets, their history, classification, technical characteristics, and the results achieved with them; and he discussed the work of Crocco, Senger, and Zander, analysed all successful launches of solid and liquid-propellant rockets, including Tikhonravov's 'Nine'.

'The most real prospects are these,' he said; 'up to altitudes of 20 to 25 kilometres flights by stratospheric propeller aircraft are possible; to heights of 50 kilometres the flights by jet-propelled stratospheric aircraft are possible, and, finally, above that, rocket flight.'

That was already something to applaud!

Very soon, however, difference of opinion arose even among the 'jet people' though, true, they did not concern general principles so much as technical details.

Korolev got particularly worked up listening to M.V. Machinsky, chairman of the Leningrad Society for the Study of Reaction Propulsion. Machinsky also spoke, it seemed, with justification, bitterly, but justifiably so.

'The development of reaction propulsion involves a whole series of purely scientific problems which have only been partially resolved, or have not even begun to be studied.'

During the recess the foyer swarmed with little groups arguing like mad.

'Here you are, arguing that reaction propulsion is still in its infancy,' Korolev attacked his opponents. 'You critisize, often rightly so, Oberth, Hohmann, Esnault-Pelterie, and Goddard, but they are doing things, designing, building, launching. And we hope not to lag behind. Who, do you think, has to take reaction engineering from its infancy to its adolescence, if not us, you and I?'

'For that we need science, instruments, ranges,' Machinsky interrupted. 'But everyone, I beg your pardon, wants to fly immediately to the stars... .'

'Zander dreamed of a flight to Mars, and that in fact was the great goal that enabled him to solve very many pressing practical problems.'

'There you are, Mars ships! Isn't it clear to you, Korolev, that all the optimism of these popular articles is fake? But you, a serious man! I claim that all talk about flying tomorrow not only to the stratosphere but even further is, at the very least, premature. What we have are random flights and random achievements.'

'We must make them systematic.'

'But to do that we must wait for the answers, or at least partial answers to a whole series of scientific and technical problems that you are just as familiar with as me.'

'But it's about time you understood,' said Korolev getting worked up, 'that the day will never come when we shall solve all the scientific and technical problems, even partially, and be able to say to ourselves:

"Well, now let's build a stratospheric aircraft." It'll never happen! It's already impossible today to determine all the most advantageous velocity curves, the optimum external profiles, the best geometry for nozzles and chambers. It's quite impossible to do that! Our grand-children will still be racking their brains over these problems. Theory and practice have to go hand in hand. It would be excellent if theory overtook practice, and lit the way for it, and prevented it from getting lost in a dead-end. But it's also possible that theory won't catch up, will lag behind, will explain, but not predict. It's happened so in the history of science.'

'Do you believe that man will fly in the stratosphere in the near future?' someone asked from behind him.

'No, I don't believe it. I simply know that he will fly,' Korolev answered.

As luck would have it, Tikhonravov spoke after Machinsky. He began to speak, it seemed, from the beginning, but irony could be easily detected in his words. He said that the very possibility of rocket flight in a vacuum had been doubted and even Goddard had made experiments on this score.

There were smiles in the hall.

Tikhonravov spoke of vulgar popularization, of foreign work, and of how rocket designers need devices to stabilize flight. But after talking about all the trials and tribulations he ended boldly: 'It may be assumed without exaggeration that an altitude of 25 to 30 kilometres is quite real in the very near future. Altitudes of 100 kilometres or more may also be attained in the not so distant future... . It is extremely alluring, without a doubt, to raise man to such heights. At present this question should be considered an open one, just the same as that of raising a man by rocket

to much lower altitudes, but there is nothing improbable about the possibility of such a flight. As a rule, instruments and various devices and mechanisms have usually preceded man into fields difficult of access to him, and then man has followed after.'

Rynin and Tikhonravov lay down the barrage. Korolev went into the attack. His paper 'The Flight of Reactive Vehicles in the Stratosphere' was down for the end of the conference. That was good and also bad—bad because people were tired, good because now he had a clear idea of the quality of the papers, knew that he would be speaking exactly to the point, and that there was no danger of losing face. He spread his papers out on the rostrum and began quietly and modestly, but with a cheekiness of context, that brought all whispering in the hall immediately to a stop.

'I shall elucidate some points relating to the flight of reactive vehicles in the stratosphere, especially emphasizing,' and he made a slight pause, 'flight, and not ascent, that is to say, movement along some path to cover a given distance.'

Korolev analysed the whole problem point by point. First, he divided reaction-propelled vehicles into three groups: solid-propellant rockets, usually using powder; vehicles with liquid-propellant rocket engines, the same as Tsiolkovsky, Goddard, Oberth, and Zander had or were working on, and, lastly, aircraft employing jet engines the theory of which had been developed by Stechkin, and with which Lorain and Crocco were experimenting. Next he made a detailed analysis of each group, an objective analysis containing a sober assessment of all their advantages, real and imaginary, without skirting a single difficulty, and wherever possible immediately making recommendations for overcoming them.

Why was a solid-propellant rocket inconvenient for stratospheric flight? Because it functioned for a very short time and produced very great accelerations. 'The work of

a reaction-propulsion engine using solid fuel is nothing but a rocket shot,' he stated.

Korolev said that the chambers of these motors were heavy because of the strength requirements and that the mechanisms for re-charging them in flight were complex in design; and, finally, dwelt on their main drawback, the low energy content of solid fuels.

Liquid-propellant engines made quite something else; and what was especially important was 'that deliberate alteration of the operational parameters of such a motor was possible during operation, i.e., control of the engine'.

Korolev stubbornly insisted on manned stratospheric flights: 'it is a matter of one, two, or even three people who will compose the crew of some of the first reaction-propulsion vehicles'.

Some of the first rocket vehicles... . One, two, three men... . Gagarin, Belyaev and Leonov, Komarov, Feoktistov and Egorov. That's how it was.

The weight of such a vehicle would not, in his opinion, 'be measured in tens or hundreds of kilograms, but would possibly be a thousand or two thousand kilograms, or heavier'.

It seemed to Korolev that he saw this unusual fantastic construction clearly before his eyes, as if the cosmodrome had already reverberated more than once with the thunder of a rocket blast-off. He talked about this start in full detail and said that the 'lift-off' will be quite slow at least at the beginning. This will be because, first, the human organism cannot stand high accelerations. An acceleration of the order of 4 g is acceptable, but only for a short time*. Moreover, it will be advisable to negotiate the dense lower layers of the atmosphere at low speeds, for otherwise it

* The acceleration of modern spaceships at blast-off does not exceed this value, i.e. four times the acceleration due to gravity.

would be necessary to overcome very substantial air resistance.

Korolev did not conceal the difficulties and did not promise quick and easy victories. 'The central problem is how to increase the efficiency of the fuel... . Another problem of no little importance is the production of alloys with a very high melting point for making the crucial parts of the engine... . We may also mention several other unsolved problems, to wit: the control of reaction-propulsion apparatus, their stability, the problems of landing (which, it may be presumed, will not be an easy business), the need to develop instruments quite new in principle to control the apparatus and for various observations, etc.'

Each line contained the coded future working programme of dozens of teams and thousands of people. Who among those sitting in the hall could predict then that 'the control of reaction-propulsion apparatus', for example, would develop into a whole branch of science, and would require new mathematical apparatus, new discoveries in gas dynamics, mechanics, and the theory of control. How brief and short was the paper actually read by Korolev in Leningrad and how enormous it looks today from the summit of the decades since.

He said a little about jet aircraft noting their advantageous weight ratio, and their greater speed and ceiling compared with piston planes. It could be immediately felt that jet engines did not interest him. He regarded this type of engines as an intermediate rung on the ladder to the stratosphere and did not conceal his intention to skip and by-pass that rung.

The fervour and conviction of the speaker suggested that he would finish on a major note full of slogans and appeals, but he ended without any pathos: 'Work on reaction-propulsion vehicles is difficult, but unusually interesting and full of promise. The difficulties will undoubtedly be overcome in the long run, even if, perhaps, it will be rather more difficult than it seems at first glance.'

The statements made by the rocketeers at the conference aroused wide comment. The Soviet journal *Aeroplane* stressed that 'the workers on reaction propulsion are presenting a "socialist bill" to the iron and steel industry for alloys heat-resistant at very high temperatures'. In another issue of the same journal a young staff member of the Reaction Propulsion Institute, A.G. Kostikov, a recent graduate from the Air Force Academy, wrote that it followed from Tikhonravov's paper that 'clearly solution of the problem of rocket flying will put this form of vehicle beyond competition in investigating the upper layers of the atmosphere'. In April 1934 *Pravda* noted: 'In an interesting report engineer S. P. Korolev (Reaction Propulsion Research Institute) analysed the possibility and reality of flight by reaction propulsion vehicles in the upper layers of the atmosphere. Central to it is the creation of liquid-propellant rocket engines. Solution of this problem will necessarily entail extremely high fuel consumption and very high temperature conditions (up to 3000°C).'

At the newspaper stand near the Dvortsovy Bridge Korolev bought five copies of *Pravda* and tucked them into an internal pocket so that no one would see it and laugh at him.

In that transparent, fragile spring when Korolev wandered through damp, sunny Leningrad, a boy was born in the little village of Klushino in a cottage covered up to the windows by snow on the road to old Gzhatsk. The mother and father smiled when hearing him yell and argued in a whisper; they could not make out what was the colour of their son's eyes.

In Leningrad Korolev could not then by any means know that, after many very hard times, sometimes cruelly unjust to him, a beautiful new spring would come when in that unknown boy's impossibly clear eyes a new world would be reflected, a world of black sky and blue Earth, a world never before seen by man.

November 1968—November 1971

POSTSCRIPT TO THE ENGLISH EDITION

THE CONSTRUCTOR GENERAL

I remember very well how I was directed from the anteroom where a secretary sat surrounded by switchboards and microphones into an immense boardroom with a long conference table, and in one corner a little table with two telephones. Along one wall there were windows and on the opposite wall display panels with drawn curtains. On entering the room I also noted a small blackboard, smaller than a school one, with traces of chalk on it, and a big globe, certainly more than a metre in diameter. There was another door in the far wall from where I entered, and I made my way through it into a small but comfortable office.

To one side of the single window stood a desk behind which a thickset, not very tall man, around fifty, rose to greet me, quickly pulling off glasses with narrow gold rims: a round balding head, bent forward, a short nose, a quick, very alert but rather sullen look; in the lines of his full face something of the tenacity of a boxer or wrestler ready for the gong. He was dressed, I would have said, challengingly simple for one in his position. A coloured nylon shirt with short sleeves, such as was all the rage, was tucked onto a pair of lightweight, light-coloured cotton trousers of a cheapness that did not seem to go with the man. On his feet were sandals with open toes. The bookkeeper in a small office might have dressed that way, or the attendant at a boat-hire landing stage, or a taxi driver. Offering his hand, he introduced himself as Korolev.

That was the way, in August 1961, that I met the hero of this story. From then until his death in January 1966 I met Korolev quite regularly, though not frequently, certainly not more than twice a year. Covering space flights for *Komsomolskaya Pravda* I interviewed Korolev on matters of

interest to the paper, but during our talks conversation also usually touched on a wide range of other topics. We even did not talk so much about space as about literature and new books and films. In 1962 I wrote a story about the builders of spaceships. It was called *The Thundersmiths.* Korolev read it in manuscript, praised it, and helped to get it published. The story interested Mosfilm Studios, so I wrote a script, and again Korolev gave his support, and appointed one of his assistants scientific consultant.

When I talked with Korolev I felt that he was interested in talking to me. First of all, I was a person from another world unknown to him; and he was a man with an extremely inquiring turn of mind. And second, I was not connected with him by any business ties; I was quite independent of him and, as he was seldom associated with such people, that also roused his interest.

People indifferent to his business, though, simply did not exist for Korolev, and soon, learning that I had been trained as a rocket engineer, he exerted himself to convert me to his passionate singlemindedness. Once, after demonstrating to me the need to write a sequel to *The Thundersmiths*, he said, as if by the way: 'But you know, you ought to make a space flight yourself.'

The upshot of that conversation was that I wrote an application asking Korolev to sign me up in the astronauts' unit. For two weeks then the doctors had me under observation in a special clinic, and passed me in general as fit. Who knows, if Korolev had not died, I might have become a spaceman.

During our meetings I was really able to appreciate the stature of this man, and the place he occupied in Soviet and world astronautics. I understood that before me was a man of historical significance in the literal sense of the term, and I did not hide my interest in him. Several times I led the conversation round to his past, to the years of his youth, but as far as I remember, he did not like this theme and

always tried to switch our talk in another direction. Once I told him straight that I wanted to write a big piece about him.

'Some other time,' Korolev said, lazily brushing it aside. 'I have no time to be bothered with that now... . There will still be time for memoirs.'

Who could have supposed then that this remarkable man, so energetic, so strong to look at, had less than a year to live?

Immediately after Korolev's death I decided to write a documentary book about him. His mother, Maria Balanina, his first wife Xenia Vincentini, their daughter Natasha, and his widow, Nina Koroleva, and many of the friends of his early years helped me with it. I journeyed to Zhitomir and Nezhin, to Kiev and Odessa, and to Koktebel, walked along the corridors of the Moscow Higher Technical School, and went down into GIRD's basement. That is how this book was born, the first of a planned trilogy about Korolev, a book about the Korolev for whom being Constructor General still lay ahead.

The gifted poet Sergei Esenin wrote that it is impossible to see a human close if it is very close and that more is seen at a distance. And you will surely agree with me when I say how difficult it is to tell not about a giant of the past whose features have been blurred by the ages, but about a contemporary, about a person that thousands of people knew, that they worked with and remember. His works have not yet become collector's pieces, they are in movement, at work; he is dead, but they live.

In all the life of this amazing man there is a startling contradiction. On the one hand Korolev was a most exact reflection of an epoch. He has become part of it, it would seem, forever and imperishably. He knew all its triumphs and drained the cup of its bitterness to the dregs. Korolev's biography is the concretization of the history of our land in one man, a drop in the ocean; but then the sun of

his day is reflected in both the drop and the ocean. And at the same time he was always a little ahead; he was outstripping his day, and outstripped it all his life. He was outstripping it in the Twenties when he was flying gliders, and later in the Thirties when he was building his first rockets, and then when he was contemplating flights to other worlds. Strangely enough, in life he was not tall, but he always seemed taller than the others when he looked ahead.

In this book you have parted with Korolev when, faithful to his idea of a rocket glider, he transferred to the Rocket Research Institute, where he became the head of a special department and continued work in the field of winged rockets. He had a mass of interesting plans, but... .

In the years of World War II they didn't want plans from rocket men but weapons, not rough, remote, long-term estimates but concrete immediate things needed at the front. In those years Korolev was engaged in designing rocket boosters to assist the take-off of heavily loaded bombers.

In the post-war years, after analysing the world's advances of recent years in rocketry, Korolev set about building a whole series of long-range ballistic missiles, and creating, with other outstanding designers and constructors, the USSR's missile defences. The pinnacle of this work was the creation of a missile system capable of reaching any point on the globe. This system became the prototype of the *Vostok* rocket.

Our first artificial earth satellite, the first sputnik, did not suddenly and immediately bleep its simple and fantastic little song above our planet. Years of work by many thousands of people paved the way for its launching. Korolev's organizational role in those years was immense; he was able, thanks to the support of the Soviet Communist Party and the Soviet Government, to gather round his constructor's bureau many, many groups of researchers in

the most varied fields. But no training and no preliminary experiments could answer all the questions facing the masters of astronautics. Every flight was an examination, and each launch a test.

Five launchings of the *Vostok* space vehicle preceded the morning of 12 April 1961, the morning of Gagarin's glory.

Gagarin slept peacefully the night before blast-off, but Korolev did not. He dropped in at the spacemen's bungalow, whispered with the doctors, picked up a magazine and began reading. Or did he make a show of reading?

Korolev listened attentively to Herman Titov when the latter proposed changing his flight from a three-orbit one into a day's flight around the Earth, and agreed to his proposals.

The most important test of the ground services of the cosmodrome was the first joint flight of two spaceships, Nikolaev's and Popovich's.

There is not a person among our first astronauts with whom the Constructor-in-Chief did not have a fatherly chat before the launching, and there was no one who asked them so many questions after their successful landing as the Constructor General.

A detailed programme of research was drawn up under Korolev's guidance to investigate circumterrestrial space, the Moon, and the planets of the solar system. I recollect my last meeting with him in November 1965. We talked about a soft landing on the Moon. Korolev was going to the Centre for Distant Space Communications, on a business visit, in order to conduct the penultimate communications session with Luna-8. He said then: 'Now we know everything. Luna-8 should land on the Moon. Of course, it is equipment, and anything can happen... . But, if Luna-8 doesn't, I guarantee that Luna-9 will.'

Three weeks after his death Luna-9 landed on the Moon and sent back the 'photograph of the age', the first panorama of the Moon's surface.

All his life Korolev was working. He had no hobbies, he did not hunt, or fish, or play patience. The grease gathered dust on the expensive Sauer double-barrelled shotgun someone gave him as a gift. He did not know how to rest or take a holiday, and was incapable of it. On Sundays he slept a lot, would wake up, read, and go to sleep again. Those who worked with him found it difficult to believe, for at work he was all unflagging energy. He was indifferent to clothes and the whims of fashion, did not like wearing suits, liked 'unofficial' soft-coloured shirts, which he wore without a tie. He spent freely, got into debt, and lent money just like that if he saw a person needed it badly. When he died there were 16 roubles 24 kopecks in his bank account, a small but eloquent touch that says much about the man.

There is no need to idealize Korolev. He was tough and harsh, but cold and daring, sly and cunning but not devious. He was blunt, but he knew his business. And the main thing about him was his ideal. Isn't it revealing that a physics student answered the question on a questionnaire: 'Who among the people of the older generation around you interests you most'?, as follows: 'I have always liked people who have ideas and who are able to carry them out. Everything that I know about Academician Korolev convinces me, and strengthens my feeling, that he is my ideal of a man. I consider that the future belongs to people like Korolev.'

Korolev was born at night on December 31st. For many years to come the astronauts of various countries, flying to distant planets, will observe Earth's custom and raise their glasses in a New Year's toast to his living memory, to his glorious cause, to his dream that they will be fulfilling, that will be fulfilled by our children and our grandchildren.

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ABOUT THE AUTHOR

Yaroslav Golovanov, an engineer by training, is a specialist in rocket engines. But while engaged in research he began dabbling in journalism and soon transferred to newspaper work. For the past 17 years he has been the space correspondent of "Komsomolskaya Pravda", the ten-million circulation Soviet youth newspaper. He visited England and Scotland (1961) and the USA (1973).

His engineering background has made him one of the leading scientific journalists in the Soviet Union. For his reporting from the Baikonur cosmodrome and his popular articles on space research he has received the top awards of the USSR Union of Journalists, the Golden Pen medal, the Tsiolkovsky and Korolev medal and the Yury Gagarin diploma. He is also the author of several novels.